United States Department of Agriculture

Natural Resources Conservation Service

United States Department of the Interior

National Park Service

Soil Survey of Little Bighorn Battlefield National Monument, Montana

How To Use This Soil Survey

This publication consists of text, tables, and a map. The text includes descriptions of detailed soil map units and provides an explanation of the information presented in the tables. It also includes a glossary of terms used in the text and tables and a list of references.

The detailed soil map can be useful in planning the use and management of small areas. To find information about your area of interest, locate that area on the map sheet. Note the map unit symbols that are in that area. Go to the Contents, which lists the map units by symbol and name and shows where each map unit is described.

The Contents shows which table has data on a specific land use for each detailed soil map unit. Also see the Contents for sections of this publication that may address your specific needs.

National Cooperative Soil Survey

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey.

The soil map in this survey may be copied without permission. Enlargement of this map, however, could cause misunderstanding of the detail of mapping. If enlarged, the map does not show the small areas of contrasting soils that could have been shown at a larger scale.

Literature Citation

The correct citation for this survey is as follows:

United States Department of Agriculture, Natural Resources Conservation Service, and United States Department of the Interior, National Park Service. 2013. Soil survey of Little Bighorn Battlefield National Monument, Montana. (Accessible online at: http://soils.usda.gov/survey/printed_surveys/)

Cover Caption

View from Last Stand Hill, looking west over some grave markers, with the Little Bighorn River in the far distance and the Custer National Cemetery to the right. The soils at Last Stand Hill are Midway silty clay loam, hilly and, at the cemetery, Thurlow silty clay loam, 4 to 8 percent slopes. The majority of the river valley area is mapped as Haverson and Glenberg soils.

Additional information about the Nation's natural resources is available online from the Natural Resources Conservation Service at http://www.nrcs.usda.gov/.

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Issued 2013

Preface

This soil survey was developed in conjunction with the National Park Service's Soil Inventory and Monitoring Program and is intended to serve as the official source document for soils occurring within Little Bighorn Battlefield National Monument, Montana.

This soil survey contains information that affects current and future land use planning in the park. It contains predictions of soil behavior for selected land uses. The survey highlights soil limitations, actions needed to overcome the limitations, and the impact of selected land uses on the environment. It is designed to meet the needs of the National Park Service and its partners to better understand the properties of the soils in the park and the effects of these properties on various natural ecological characteristics. This knowledge can help the National Park Service and its partners to understand, protect, and enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. The information in this report is intended to identify soil properties that are used in making various land use or land treatment decisions. Statements made in this report are intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. The location of each map unit is shown on the detailed soil map. Each soil in the survey area is described, and information on specific uses is given. Help in using this publication and additional information are available at the local office of the Natural Resources Conservation Service or the park office for Little Bighorn Battlefield National Monument.

Soil Survey of
Little Bighorn Battlefield National Monument, Montana

United States Department of Agriculture, Natural Resources Conservation Service, and United States Department of the Interior, National Park Service

How This Survey Was Made

This survey was made in conjunction with the National Park Service's Soil Inventory and Monitoring Program to provide information about the soils and miscellaneous areas within Little Bighorn Battlefield National Monument.

The soil survey data for the park was clipped from the soil survey of Big Horn County, Montana that was initiated in October 1964. The final correlation for the county survey was completed in December 1970. Mapping was performed at a scale of 1:24,000. The soil data was reposted to the Soil Data Mart in September 2010 and included edits to the attribute data but not edits to the spatial data. At the time that this document was assembled for the area of Little Bighorn Battlefield National Monument (January 2013), there were 13 different map units comprised of 47 map unit components.

Sections of this report were reviewed by State-based staff from NRCS and by soils staff at the University of California, Davis.

During the soil survey, ecological sites and soil component relationships were observed. Soil-site correlation concepts were established to help in designing the map units. Soil and plant specialists tested the concepts during mapping and collected field documentation at numerous points across the landscape. Ecological sites were assigned to most, but not all, of the soil components in each map unit.

The information in this report includes a description of the soils and miscellaneous areas and their location and a discussion of their suitability, limitations, and management for specified uses. Soil scientists observed the steepness, length, and shape of the slopes; the general patterns of drainage; the kinds of native plants; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

The soils and miscellaneous areas in the survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units).

Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they delineated the boundaries of these bodies on digital imagery and identified each as a specific map unit.

Detailed Soil Map Units

The map units delineated on the detailed soil map in this survey represent the soils or miscellaneous areas in the park. The map unit descriptions in this section, along with the map, can be used to determine the suitability and potential of a unit for specific uses. They also can be used to plan the management needed for those uses.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the map. The contrasting components are mentioned in the map unit descriptions. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. All the soils of a series have major horizons that are similar in composition, thickness, and arrangement. The soils of a given series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil map are phases of soil series. The name of a soil

phase commonly indicates a feature that affects use or management. For example, Haverson loam, 0 to 2 percent slopes, is a phase of the Haverson series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes. A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the map. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Clapper-Midway complex, hilly, is an example.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Shale outcrop is an example.

Table 1 lists each map unit in the park, its major and minor components, and the percentage of each component in the unit. Other tables give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils or miscellaneous areas.

345897—Clapper-Midway complex, hilly

Map Unit Setting

Major land resource area (MLRA): 58A—Northern Rolling High Plains, Northern Part
Elevation: 2,495 to 3,995 feet
Mean annual precipitation: 10 to 14 inches
Mean annual air temperature: 45 to 48 degrees F
Frost-free period: 100 to 125 days

Map Unit Composition

Clapper and similar soils: 55 percent
Midway and similar soils: 35 percent
Dissimilar minor components: 10 percent

Description of the Clapper Soil

Classification
Soil taxonomic classification: Loamy-skeletal, mixed, superactive, mesic Ustollic Calciorthids
Ecological site name and identification symbol: Silty (Si) RRU 58A-E 10-14” p.z. (R058AE001MT)

Setting
Landscape: Plains
Landform: Paleoterraces
Landform position (two-dimensional): Summit and shoulder
Slope range: 15 to 35 percent
Down-slope shape: Linear
Across-slope shape: Linear
Representative aspect: North
Soil temperature class: Mesic
Soil temperature regime: Mesic

Properties and Qualities
Parent material: Gravelly alluvium
Restrictive feature(s): None within a depth of 60 inches
Frequency of flooding: None
Frequency of ponding: None
Depth to water table: More than 72 inches
Drainage class: Well drained

Shrink-swell potential: Moderate (about 4.5 LEP)
Salinity maximum: Very slightly saline (about 2.0 mmhos/cm)
Sodicity maximum: Not sodic
Calcium carbonate equivalent (maximum weight percentage): 28
Available water capacity: Low (about 4.8 inches)

Interpretive Groups
Land capability subclass (nonirrigated): 6e
Meets hydric soil criteria: No
Hydrologic soil group: B

Vegetation
Existing plants: Western wheatgrass, bluebunch wheatgrass, sideoats grama, prairie Junegrass, plains muhly, other perennial grasses, little bluestem, needle and thread, and green needlegrass

Typical Profile
A—0 to 4 inches; gravelly loam
Bk1—4 to 16 inches; gravelly loam
Bk2—16 to 60 inches; very gravelly loam

Description of the Midway Soil

Classification
Soil taxonomic classification: Clayey, smectitic (calcareous), calcareous, frigid, shallow Ustic Torriorthents
Ecological site name and identification symbol: Clayey (Cy) RRU 58A-E 10-14” p.z. (R058AE002MT)

Setting
Landscape: Plains
Landform: Hills
Landform position (two-dimensional): Summit and shoulder
Slope range: 15 to 40 percent
Down-slope shape: Linear
Across-slope shape: Linear
Representative aspect: North
Soil temperature class: Frigid
Soil temperature regime: Frigid

Properties and Qualities
Parent material: Residuum weathered from shale
Restrictive feature(s): Paralithic bedrock at a depth of 10 to 20 inches
Frequency of flooding: None
Frequency of ponding: None
Depth to water table: More than 72 inches
Drainage class: Well drained
Shrink-swell potential: High (about 7.5 LEP)
Salinity maximum: Not saline
Sodicity maximum: Not sodic
Calcium carbonate equivalent (maximum weight percentage): 8
Available water capacity: Very low (about 1.9 inches)

Interpretive Groups
Land capability subclass (nonirrigated): 7e
Meets hydric soil criteria: No
Hydrologic soil group: D

Vegetation
Existing plants: Western wheatgrass, bluebunch wheatgrass, big sagebrush, other perennial forbs, and green needlegrass

Typical Profile
A—0 to 2 inches; clay loam
C—2 to 11 inches; clay
Cr—11 to 60 inches; bedrock

Minor Components

Rock outcrop
Percent of map unit: 10 percent
Representative aspect: North
Meets hydric soil criteria: No

345971—Haverson and Glenberg soils

Map Unit Setting

Major land resource area (MLRA): 58A—Northern Rolling High Plains, Northern Part
Elevation: 1,895 to 6,000 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 37 to 45 degrees F
Frost-free period: 110 to 125 days

Map Unit Composition

Glenberg and similar soils: 45 percent
Haverson and similar soils: 45 percent
Dissimilar minor components: 10 percent

Description of the Glenberg Soil

Classification
Soil taxonomic classification: Coarse-loamy, mixed (calcareous), superactive, calcareous, frigid Ustic Torrifluvents
Ecological site name and identification symbol: None assigned

Setting
Landscape: Valleys
Landform: Stream terraces
Slope range: 0 to 2 percent
Down-slope shape: Linear
Across-slope shape: Linear
Representative aspect: North
Soil temperature class: Frigid
Soil temperature regime: Frigid

Properties and Qualities
Parent material: Sandy alluvium
Restrictive feature(s): None within a depth of 60 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Depth to water table: More than 72 inches
Drainage class: Well drained
Shrink-swell potential: Low (about 1.5 LEP)
Salinity maximum: Slightly saline (about 5.0 mmhos/cm)
Sodicity maximum: Not sodic

Calcium carbonate equivalent (maximum weight percentage): 8
Available water capacity: Moderate (about 7.2 inches)

Interpretive Groups
Land capability subclass (nonirrigated and irrigated): 4w
Meets hydric soil criteria: No
Hydrologic soil group: A

Vegetation
Existing plants: Western wheatgrass, big bluestem, silver sagebrush, prairie sandreed, winterfat, common chokecherry, rose, little bluestem, silver buffaloberry, needle and thread, green needlegrass, and common snowberry

Typical Profile
A—0 to 5 inches; fine sandy loam
C—5 to 60 inches; stratified loamy fine sand to silt loam

Description of the Haverson Soil

Classification
Soil taxonomic classification: Fine-loamy, mixed (calcareous), superactive, calcareous, frigid Ustic Torrifluvents
Ecological site name and identification symbol: None assigned

Setting
Landscape: Valleys
Landform: Flood plains and stream terraces
Slope range: 0 to 2 percent
Down-slope shape: Linear
Across-slope shape: Linear
Representative aspect: North
Soil temperature class: Frigid
Soil temperature regime: Frigid

Properties and Qualities
Parent material: Alluvium
Restrictive feature(s): None within a depth of 60 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Depth to water table: More than 72 inches
Drainage class: Well drained
Shrink-swell potential: Low (about 1.5 LEP)
Salinity maximum: Very slightly saline (about 2.0 mmhos/cm)
Sodicity maximum: Not sodic
Calcium carbonate equivalent (maximum weight percentage): 3
Available water capacity: High (about 9.8 inches)

Interpretive Groups
Land capability subclass: Nonirrigated areas—3w; irrigated areas—2w
Meets hydric soil criteria: No
Hydrologic soil group: B

Vegetation
Existing plants: Western wheatgrass, bluebunch wheatgrass, big bluestem, silver sagebrush, needle and thread, and green needlegrass

Typical Profile
A—0 to 12 inches; loam
C—12 to 60 inches; stratified loam to fine sandy loam

Minor Components

Havre soils
Percent of map unit: 4 percent
Landform: Stream terraces and flood plains
Representative aspect: North
Slope range: 0 to 2 percent
Down-slope shape: Linear
Across-slope shape: Linear
Meets hydric soil criteria: No

Riverwash
Percent of map unit: 4 percent
Representative aspect: North
Meets hydric soil criteria: No

Somewhat poorly drained soils
Percent of map unit: 2 percent
Landform: Depressions
Representative aspect: North
Down-slope shape: Linear
Across-slope shape: Linear
Meets hydric soil criteria: Yes

345982—Haverson loam, 0 to 2 percent slopes

Map Unit Setting

Major land resource area (MLRA): 58A—Northern Rolling High Plains, Northern Part
Elevation: 1,895 to 6,000 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 37 to 45 degrees F
Frost-free period: 110 to 125 days

Map Unit Composition

Haverson and similar soils: 90 percent
Dissimilar minor components: 10 percent

Description of the Haverson Soil

Classification
Soil taxonomic classification: Fine-loamy, mixed (calcareous), superactive, calcareous, frigid Ustic Torrifluvents
Ecological site name and identification symbol: Silty (Si) RRU 58A-E 10-14” p.z. (R058AE001MT)

Setting
Landscape: Valleys
Landform: Flood plains and stream terraces
Slope range: 0 to 2 percent
Down-slope shape: Linear
Across-slope shape: Linear
Representative aspect: North
Soil temperature class: Frigid
Soil temperature regime: Frigid

Properties and Qualities
Parent material: Alluvium

Restrictive feature(s): None within a depth of 60 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Depth to water table: More than 72 inches
Drainage class: Well drained
Shrink-swell potential: Low (about 1.5 LEP)
Salinity maximum: Very slightly saline (about 2.0 mmhos/cm)
Sodicity maximum: Not sodic
Calcium carbonate equivalent (maximum weight percentage): 3
Available water capacity: High (about 9.8 inches)

Interpretive Groups
Land capability subclass: Nonirrigated areas—3w; irrigated areas—2w
Meets hydric soil criteria: No
Hydrologic soil group: B

Vegetation
Existing plants: Western wheatgrass, bluebunch wheatgrass, big bluestem, silver sagebrush, needle and thread, and green needlegrass

Typical Profile
A—0 to 12 inches; loam
C—12 to 60 inches; stratified loam to fine sandy loam

Minor Components

Glenberg soils
Percent of map unit: 8 percent
Landform: Flood plains and stream terraces
Representative aspect: North
Slope range: 1 to 4 percent
Down-slope shape: Linear
Across-slope shape: Linear
Meets hydric soil criteria: Yes

Somewhat poorly drained soils
Percent of map unit: 2 percent
Landform: Flood plains
Representative aspect: North
Down-slope shape: Linear
Across-slope shape: Linear
Meets hydric soil criteria: Yes

345992—Heldt silty clay loam, 4 to 8 percent slopes

Map Unit Setting

Major land resource area (MLRA): 58A—Northern Rolling High Plains, Northern Part
Elevation: 2,200 to 4,300 feet
Mean annual precipitation: 10 to 14 inches
Mean annual air temperature: 39 to 45 degrees F
Frost-free period: 100 to 125 days

Map Unit Composition

Heldt and similar soils: 90 percent
Dissimilar minor components: 10 percent

Description of the Heldt Soil

Classification

Soil taxonomic classification: Fine, smectitic Borollic Camborthids
Ecological site name and identification symbol: Clayey (Cy) RRU 58A-E 10-14” p.z. (R058AE002MT)

Setting

Landscape: Plains
Landform: Hills
Landform position (two-dimensional): Footslope
Slope range: 4 to 8 percent
Down-slope shape: Linear
Across-slope shape: Linear
Representative aspect: North
Soil temperature class: Frigid
Soil temperature regime: Frigid

Properties and Qualities

Parent material: Alluvium
Restrictive feature(s): None within a depth of 60 inches
Frequency of flooding: None
Frequency of ponding: None
Depth to water table: More than 72 inches
Drainage class: Well drained
Shrink-swell potential: High (about 7.5 LEP)
Salinity maximum: Nonsaline (about 1.0 mmho/cm)
Sodicity maximum: Sodium adsorption ratio of 8.0
Calcium carbonate equivalent (maximum weight percentage): 10
Available water capacity: High (about 9.7 inches)

Interpretive Groups

Land capability subclass (nonirrigated and irrigated): 3e
Meets hydric soil criteria: No
Hydrologic soil group: C

Vegetation

Existing plants: Western wheatgrass, bluebunch wheatgrass, other perennial forbs, other shrubs, and green needlegrass

Typical Profile

A—0 to 4 inches; silty clay loam
Bw—4 to 10 inches; silty clay
Bk—10 to 22 inches; silty clay
C—22 to 60 inches; silty clay

Minor Components

Lohmiller soils

Percent of map unit: 6 percent
Landform: Hills and alluvial fans
Geomorphic position (two-dimensional): Footslope
Representative aspect: North
Slope range: 4 to 8 percent
Down-slope shape: Linear
Across-slope shape: Linear
Meets hydric soil criteria: No

Midway soils
Percent of map unit: 4 percent
Landform: Hills
Geomorphic position (two-dimensional): Summit and shoulder
Representative aspect: North
Slope range: 2 to 8 percent
Down-slope shape: Linear
Across-slope shape: Linear
Meets hydric soil criteria: No

345999—Hesper silty clay loam, 4 to 8 percent slopes

Map Unit Setting

Major land resource area (MLRA): 58A—Northern Rolling High Plains, Northern Part
Elevation: 2,700 to 3,995 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 45 to 48 degrees F
Frost-free period: 110 to 125 days

Map Unit Composition

Hesper and similar soils: 90 percent
Dissimilar minor components: 10 percent

Description of the Hesper Soil

Classification
Soil taxonomic classification: Fine, smectitic, mesic Ustollic Haplargids
Ecological site name and identification symbol: Clayey (Cy) RRU 58A-E 10-14” p.z. (R058AE002MT)

Setting
Landscape: Plains
Landform: Paleoterraces
Slope range: 4 to 8 percent
Down-slope shape: Linear
Across-slope shape: Linear
Representative aspect: North
Soil temperature class: Mesic
Soil temperature regime: Mesic

Properties and Qualities
Parent material: Alluvium and/or eolian deposits
Restrictive feature(s): None within a depth of 60 inches
Frequency of flooding: None
Frequency of ponding: None
Depth to water table: More than 72 inches
Drainage class: Well drained
Shrink-swell potential: High (about 7.5 LEP)
Salinity maximum: Nonsaline (about 1.0 mmho/cm)
Sodicity maximum: Not sodic
Calcium carbonate equivalent (maximum weight percentage): 10
Available water capacity: High (about 10.2 inches)

Interpretive Groups
Land capability subclass (nonirrigated and irrigated): 3e

Meets hydric soil criteria: No
Hydrologic soil group: C

Vegetation
Existing plants: Thickspike wheatgrass, western wheatgrass, needle and thread, and green needlegrass

Typical Profile
Ap—0 to 6 inches; silty clay loam
Bt—6 to 14 inches; silty clay
BC—14 to 22 inches; silty clay loam
Ck—22 to 49 inches; silty clay loam
2C—49 to 60 inches; very gravelly sand

Minor Components

Keiser soils
Percent of map unit: 10 percent
Landform: Alluvial fans and paleoterraces
Representative aspect: North
Slope range: 4 to 8 percent
Down-slope shape: Linear
Across-slope shape: Linear
Meets hydric soil criteria: No

346062—Midway silty clay loam, rolling

Map Unit Setting

Major land resource area (MLRA): 58A—Northern Rolling High Plains, Northern Part
Elevation: 2,200 to 4,995 feet
Mean annual precipitation: 10 to 14 inches
Mean annual air temperature: 39 to 48 degrees F
Frost-free period: 100 to 125 days

Map Unit Composition

Midway and similar soils: 90 percent
Dissimilar minor components: 10 percent

Description of the Midway Soil

Classification
Soil taxonomic classification: Clayey, smectitic (calcareous), calcareous, frigid, shallow Ustic Torriorthents
Ecological site name and identification symbol: Clayey (Cy) RRU 58A-E 10-14” p.z. (R058AE002MT)

Setting
Landscape: Plains
Landform: Hills
Landform position (two-dimensional): Summit and shoulder
Slope range: 8 to 15 percent
Down-slope shape: Linear
Across-slope shape: Linear
Representative aspect: North
Soil temperature class: Frigid
Soil temperature regime: Frigid

Properties and Qualities
Parent material: Residuum weathered from shale
Restrictive feature(s): Paralithic bedrock at a depth of 10 to 20 inches
Frequency of flooding: None
Frequency of ponding: None
Depth to water table: More than 72 inches
Drainage class: Well drained
Shrink-swell potential: High (about 7.5 LEP)
Salinity maximum: Not saline
Sodicity maximum: Not sodic
Calcium carbonate equivalent (maximum weight percentage): 8
Available water capacity: Very low (about 1.9 inches)

Interpretive Groups
Land capability subclass (nonirrigated): 6e
Meets hydric soil criteria: No
Hydrologic soil group: D

Vegetation
Existing plants: Western wheatgrass, bluebunch wheatgrass, big sagebrush, other perennial forbs, and green needlegrass

Typical Profile
A—0 to 2 inches; silty clay loam
C—2 to 11 inches; clay
Cr—11 to 60 inches; bedrock

Minor Components

Heldt soils
Percent of map unit: 3 percent
Landform: Hills
Geomorphic position (two-dimensional): Footslope
Representative aspect: North
Slope range: 8 to 15 percent
Down-slope shape: Linear
Across-slope shape: Linear
Meets hydric soil criteria: No

McRae soils
Percent of map unit: 3 percent
Landform: Hills and alluvial fans
Geomorphic position (two-dimensional): Footslope
Representative aspect: North
Slope range: 4 to 8 percent
Down-slope shape: Linear
Across-slope shape: Linear
Meets hydric soil criteria: No

Lohmiller soils
Percent of map unit: 2 percent
Landform: Stream terraces and alluvial fans
Representative aspect: North
Slope range: 8 to 15 percent
Down-slope shape: Linear
Across-slope shape: Linear
Meets hydric soil criteria: No

Nelson soils
Percent of map unit: 1 percent
Landform: Hills
Geomorphic position (two-dimensional): Shoulder and backslope
Representative aspect: North
Slope range: 2 to 15 percent
Down-slope shape: Linear
Across-slope shape: Linear
Meets hydric soil criteria: No

Thedalund soils
Percent of map unit: 1 percent
Landform: Hills
Geomorphic position (two-dimensional): Shoulder and backslope
Representative aspect: North
Slope range: 8 to 15 percent
Down-slope shape: Linear
Across-slope shape: Linear
Meets hydric soil criteria: No

346063—Midway silty clay loam, hilly

Map Unit Setting

Major land resource area (MLRA): 58A—Northern Rolling High Plains, Northern Part
Elevation: 2,200 to 4,300 feet
Mean annual precipitation: 10 to 14 inches
Mean annual air temperature: 39 to 45 degrees F
Frost-free period: 100 to 125 days

Map Unit Composition

Midway and similar soils: 80 percent
Dissimilar minor components: 20 percent

Description of the Midway Soil

Classification
Soil taxonomic classification: Clayey, smectitic (calcareous), calcareous, frigid, shallow Ustic Torriorthents
Ecological site name and identification symbol: Shallow Clay (SwC) RRU 58A-E 10-14” p.z. (R058AE199MT)

Setting
Landscape: Plains
Landform: Hills
Landform position (two-dimensional): Summit and shoulder
Slope range: 15 to 35 percent
Down-slope shape: Linear
Across-slope shape: Linear
Representative aspect: North
Soil temperature class: Frigid
Soil temperature regime: Frigid

Properties and Qualities
Parent material: Residuum weathered from shale
Restrictive feature(s): Paralithic bedrock at a depth of 10 to 20 inches

Frequency of flooding: None
Frequency of ponding: None
Depth to water table: More than 72 inches
Drainage class: Well drained
Shrink-swell potential: High (about 7.5 LEP)
Salinity maximum: Not saline
Sodicity maximum: Not sodic
Calcium carbonate equivalent (maximum weight percentage): 8
Available water capacity: Very low (about 1.9 inches)

Interpretive Groups
Land capability subclass (nonirrigated): 7e
Meets hydric soil criteria: No
Hydrologic soil group: D

Vegetation
Existing plants: Western wheatgrass, bluebunch wheatgrass, big sagebrush, other perennial forbs, and green needlegrass

Typical Profile
A—0 to 2 inches; silty clay loam
C—2 to 11 inches; clay
Cr—11 to 60 inches; bedrock

Minor Components

Heldt soils
Percent of map unit: 8 percent
Landform: Hills
Geomorphic position (two-dimensional): Footslope
Representative aspect: North
Slope range: 8 to 15 percent
Down-slope shape: Linear
Across-slope shape: Linear
Meets hydric soil criteria: No

Lohmiller soils
Percent of map unit: 7 percent
Landform: Stream terraces and alluvial fans
Representative aspect: North
Slope range: 8 to 15 percent
Down-slope shape: Linear
Across-slope shape: Linear
Meets hydric soil criteria: No

Rock outcrop
Percent of map unit: 5 percent
Representative aspect: North
Meets hydric soil criteria: No

346097—Pierre-Lismas clays, hilly

Map Unit Setting

Major land resource area (MLRA): 58A—Northern Rolling High Plains, Northern Part
Elevation: 2,400 to 5,600 feet
Mean annual precipitation: 12 to 14 inches

Mean annual air temperature: 39 to 50 degrees F
Frost-free period: 110 to 125 days

Map Unit Composition

Lismas and similar soils: 60 percent
Pierre and similar soils: 30 percent
Dissimilar minor components: 10 percent

Description of the Lismas Soil

Classification
Soil taxonomic classification: Clayey, smectitic (calcareous), nonacid, frigid, shallow Ustic Torriorthents
Ecological site name and identification symbol: Shallow Clay (SwC) RRU 58A-E 10-14” p.z. (R058AE199MT)

Setting
Landscape: Plains
Landform: Hills
Landform position (two-dimensional): Summit and shoulder
Slope range: 25 to 45 percent
Down-slope shape: Linear
Across-slope shape: Linear
Representative aspect: North
Soil temperature class: Frigid
Soil temperature regime: Frigid

Properties and Qualities
Parent material: Residuum weathered from shale
Restrictive feature(s): Paralithic bedrock at a depth of 10 to 20 inches
Frequency of flooding: None
Frequency of ponding: None
Depth to water table: More than 72 inches
Drainage class: Well drained
Shrink-swell potential: High (about 7.5 LEP)
Salinity maximum: Very slightly saline (about 2.0 mmhos/cm)
Sodicity maximum: Not sodic
Calcium carbonate equivalent (maximum weight percentage): 3
Available water capacity: Very low (about 2.5 inches)

Interpretive Groups
Land capability subclass (nonirrigated): 7e
Meets hydric soil criteria: No
Hydrologic soil group: D

Vegetation
Existing plants: Thickspike wheatgrass, western wheatgrass, big sagebrush, plains muhly, other perennial grasses, little bluestem, and green needlegrass

Typical Profile
A—0 to 6 inches; clay
C—6 to 18 inches; clay
Cr—18 to 60 inches; bedrock

Description of the Pierre Soil

Classification
Soil taxonomic classification: Fine, smectitic, frigid Udorthentic Chromusterts

Ecological site name and identification symbol: Clayey (Cy) RRU 58A-E 10-14” p.z. (R058AE002MT)

Setting
Landscape: Plains
Landform: Hills
Landform position (two-dimensional): Backslope and footslope
Slope range: 15 to 20 percent
Down-slope shape: Linear
Across-slope shape: Linear
Representative aspect: North
Soil temperature class: Frigid
Soil temperature regime: Frigid

Properties and Qualities
Parent material: Clayey residuum weathered from shale
Restrictive feature(s): Paralithic bedrock at a depth of 20 to 40 inches
Frequency of flooding: None
Frequency of ponding: None
Depth to water table: More than 72 inches
Drainage class: Well drained
Shrink-swell potential: High (about 7.5 LEP)
Salinity maximum: Very slightly saline (about 2.0 mmhos/cm)
Sodicity maximum: Sodium adsorption ratio of 1.0
Calcium carbonate equivalent (maximum weight percentage): 10
Available water capacity: Low (about 4.4 inches)

Interpretive Groups
Land capability subclass (nonirrigated): 6e
Meets hydric soil criteria: No
Hydrologic soil group: D

Vegetation
Existing plants: Western wheatgrass, bluebunch wheatgrass, other perennial forbs, other perennial grasses, other shrubs, and green needlegrass

Typical Profile
A—0 to 3 inches; clay
Bssy—3 to 29 inches; silty clay
Cr—29 to 60 inches; bedrock

Minor Components

Harvey soils
Percent of map unit: 5 percent
Landform: Hills
Geomorphic position (two-dimensional): Footslope
Representative aspect: North
Slope range: 8 to 15 percent
Down-slope shape: Linear
Across-slope shape: Linear
Meets hydric soil criteria: No

Rock outcrop
Percent of map unit: 5 percent
Representative aspect: North
Meets hydric soil criteria: No

346102—Pierre clay, rolling

Map Unit Setting

Major land resource area (MLRA): 58A—Northern Rolling High Plains, Northern Part
Elevation: 1,895 to 4,500 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 39 to 45 degrees F
Frost-free period: 110 to 125 days

Map Unit Composition

Pierre and similar soils: 85 percent
Dissimilar minor components: 15 percent

Description of the Pierre Soil

Classification
Soil taxonomic classification: Fine, smectitic, frigid Udorthentic Chromusterts
Ecological site name and identification symbol: Clayey (Cy) RRU 58A-E 10-14” p.z. (R058AE002MT)

Setting
Landscape: Plains
Landform: Hills
Landform position (two-dimensional): Backslope and footslope
Slope range: 8 to 15 percent
Down-slope shape: Linear
Across-slope shape: Linear
Representative aspect: North
Soil temperature class: Frigid
Soil temperature regime: Frigid

Properties and Qualities
Parent material: Clayey residuum weathered from shale
Restrictive feature(s): Paralithic bedrock at a depth of 20 to 40 inches
Frequency of flooding: None
Frequency of ponding: None
Depth to water table: More than 72 inches
Drainage class: Well drained
Shrink-swell potential: High (about 7.5 LEP)
Salinity maximum: Very slightly saline (about 2.0 mmhos/cm)
Sodicity maximum: Sodium adsorption ratio of 1.0
Calcium carbonate equivalent (maximum weight percentage): 10
Available water capacity: Low (about 4.4 inches)

Interpretive Groups
Land capability subclass (nonirrigated): 4e
Meets hydric soil criteria: No
Hydrologic soil group: D

Vegetation
Existing plants: Western wheatgrass, bluebunch wheatgrass, other perennial forbs, other perennial grasses, other shrubs, and green needlegrass

Typical Profile
A—0 to 3 inches; clay
Bssy—3 to 29 inches; silty clay
Cr—29 to 60 inches; bedrock

Minor Components

Lismas soils
Percent of map unit: 8 percent
Landform: Hills
Geomorphic position (two-dimensional): Summit and shoulder
Representative aspect: North
Slope range: 4 to 8 percent
Down-slope shape: Linear
Across-slope shape: Linear
Meets hydric soil criteria: No

Kyle soils
Percent of map unit: 7 percent
Geomorphic position (two-dimensional): Footslope
Representative aspect: North
Slope range: 4 to 8 percent
Down-slope shape: Linear
Across-slope shape: Linear
Meets hydric soil criteria: No

346139—Shale outcrop

Map Unit Setting

Major land resource area (MLRA): 58A—Northern Rolling High Plains, Northern Part
Elevation: 2,495 to 4,995 feet
Mean annual precipitation: 12 to 17 inches
Mean annual air temperature: 39 to 45 degrees F
Frost-free period: 95 to 125 days

Map Unit Composition

Rock outcrop, shale: 80 percent
Dissimilar minor components: 20 percent

Description of Rock Outcrop, Shale

This map unit consists of exposures of shale of Upper Cretaceous age (99.6 million to 65.5 million years ago) that include the Bearpaw Formation and the Judith River Formation.

Minor Components

Eltsac soils
Percent of map unit: 10 percent
Landform: Hills
Geomorphic position (two-dimensional): Summit, shoulder, and backslope
Representative aspect: North
Slope range: 15 to 35 percent
Down-slope shape: Linear
Across-slope shape: Linear
Meets hydric soil criteria: No

Norbert soils
Percent of map unit: 10 percent
Landform: Hills
Geomorphic position (two-dimensional): Summit, shoulder, and backslope
Representative aspect: North

Slope range: 15 to 70 percent
Down-slope shape: Linear
Across-slope shape: Linear
Meets hydric soil criteria: No

346140—Shale outcrop-Midway complex, steep

Map Unit Setting

Major land resource area (MLRA): 58A—Northern Rolling High Plains, Northern Part
Elevation: 2,200 to 4,500 feet
Mean annual precipitation: 10 to 14 inches
Mean annual air temperature: 39 to 45 degrees F
Frost-free period: 100 to 125 days

Map Unit Composition

Rock outcrop, shale: 45 percent
Midway and similar soils: 35 percent
Dissimilar minor components: 20 percent

Description of Rock Outcrop, Shale

This map unit consists of exposures of shale of Upper Cretaceous age (99.6 million to 65.5 million years ago) that include the Bearpaw Formation and the Judith River Formation.

Description of the Midway Soil

Classification
Soil taxonomic classification: Clayey, smectitic (calcareous), calcareous, frigid, shallow Ustic Torriorthents
Ecological site name and identification symbol: Clayey (Cy) RRU 58A-E 10-14” p.z. (R058AE002MT)

Setting
Landscape: Plains
Landform: Hills
Landform position (two-dimensional): Summit and shoulder
Slope range: 25 to 70 percent
Down-slope shape: Linear
Across-slope shape: Linear
Representative aspect: North
Soil temperature class: Frigid
Soil temperature regime: Frigid

Properties and Qualities
Parent material: Residuum weathered from shale
Restrictive feature(s): Paralithic bedrock at a depth of 10 to 20 inches
Frequency of flooding: None
Frequency of ponding: None
Depth to water table: More than 72 inches
Drainage class: Well drained
Shrink-swell potential: High (about 7.5 LEP)
Salinity maximum: Not saline
Sodicity maximum: Not sodic

Calcium carbonate equivalent (maximum weight percentage): 8
Available water capacity: Very low (about 1.9 inches)

Interpretive Groups
Land capability subclass (nonirrigated): 7e
Meets hydric soil criteria: No
Hydrologic soil group: D

Vegetation
Existing plants: Western wheatgrass, bluebunch wheatgrass, big sagebrush, other perennial forbs, and green needlegrass

Typical Profile
A—0 to 2 inches; silty clay loam
C—2 to 11 inches; clay
Cr—11 to 60 inches; bedrock

Minor Components

Heldt soils
Percent of map unit: 7 percent
Landform: Hills
Geomorphic position (two-dimensional): Footslope
Representative aspect: North
Slope range: 8 to 15 percent
Down-slope shape: Linear
Across-slope shape: Linear
Meets hydric soil criteria: No

Lismas soils
Percent of map unit: 7 percent
Landform: Hills
Geomorphic position (two-dimensional): Summit and shoulder
Representative aspect: North
Slope range: 20 to 35 percent
Down-slope shape: Linear
Across-slope shape: Linear
Meets hydric soil criteria: No

Pierre soils
Percent of map unit: 6 percent
Landform: Hills
Geomorphic position (two-dimensional): Backslope and footslope
Representative aspect: North
Slope range: 15 to 20 percent
Down-slope shape: Linear
Across-slope shape: Linear
Meets hydric soil criteria: No

346194—Thurlow silty clay loam, 0 to 1 percent slopes

Map Unit Setting

Major land resource area (MLRA): 58A—Northern Rolling High Plains, Northern Part
Elevation: 2,200 to 4,500 feet
Mean annual precipitation: 12 to 15 inches
Mean annual air temperature: 45 to 48 degrees F
Frost-free period: 110 to 125 days

Map Unit Composition

Thurlow and similar soils: 85 percent
Dissimilar minor components: 15 percent

Description of the Thurlow Soil

Classification
Soil taxonomic classification: Fine, smectitic, mesic Ustollic Haplargids
Ecological site name and identification symbol: Clayey (Cy) RRU 58A-E 10-14” p.z. (R058AE002MT)

Setting
Landscape: Valleys
Landform: Alluvial fans and stream terraces
Slope range: 0 to 1 percent
Down-slope shape: Linear
Across-slope shape: Linear
Representative aspect: North
Soil temperature class: Mesic
Soil temperature regime: Mesic

Properties and Qualities
Parent material: Alluvium
Restrictive feature(s): None within a depth of 60 inches
Frequency of flooding: None
Frequency of ponding: None
Depth to water table: More than 72 inches
Drainage class: Well drained
Shrink-swell potential: Moderate (about 4.5 LEP)
Salinity maximum: Nonsaline (about 1.0 mmho/cm)
Sodicity maximum: Not sodic
Calcium carbonate equivalent (maximum weight percentage): 10
Available water capacity: High (about 9.2 inches)

Interpretive Groups
Land capability subclass: Nonirrigated areas—3c; irrigated areas—2c
Meets hydric soil criteria: No
Hydrologic soil group: C

Vegetation
Existing plants: Western wheatgrass, bluebunch wheatgrass, big sagebrush, lomatium, other perennial forbs, other perennial grasses, little bluestem, and green needlegrass

Typical Profile
A—0 to 2 inches; silty clay loam
Bt—2 to 13 inches; silty clay
Bk—13 to 61 inches; silty clay loam

Minor Components

Hydro soils
Percent of map unit: 9 percent
Landform: Alluvial fans and stream terraces
Representative aspect: North
Slope range: 0 to 2 percent
Down-slope shape: Linear

Across-slope shape: Linear
Meets hydric soil criteria: No

Allentine soils
Percent of map unit: 6 percent
Landform: Alluvial fans and stream terraces
Representative aspect: North
Slope range: 0 to 2 percent
Down-slope shape: Linear
Across-slope shape: Linear
Meets hydric soil criteria: No

346196—Thurlow silty clay loam, 4 to 8 percent slopes

Map Unit Setting

Major land resource area (MLRA): 58A—Northern Rolling High Plains, Northern Part
Elevation: 2,200 to 4,300 feet
Mean annual precipitation: 10 to 14 inches
Mean annual air temperature: 39 to 48 degrees F
Frost-free period: 100 to 125 days

Map Unit Composition

Thurlow and similar soils: 85 percent
Dissimilar minor components: 15 percent

Description of the Thurlow Soil

Classification
Soil taxonomic classification: Fine, smectitic, mesic Ustollic Haplargids
Ecological site name and identification symbol: Clayey (Cy) RRU 58A-E 10-14” p.z. (R058AE002MT)

Setting
Landscape: Plains
Landform: Alluvial fans and hills
Landform position (two-dimensional): Footslope
Slope range: 4 to 8 percent
Down-slope shape: Linear
Across-slope shape: Linear
Representative aspect: North
Soil temperature class: Mesic
Soil temperature regime: Mesic

Properties and Qualities
Parent material: Alluvium
Restrictive feature(s): None within a depth of 60 inches
Frequency of flooding: None
Frequency of ponding: None
Depth to water table: More than 72 inches
Drainage class: Well drained
Shrink-swell potential: Moderate (about 4.5 LEP)
Salinity maximum: Nonsaline (about 1.0 mmho/cm)
Sodicity maximum: Not sodic
Calcium carbonate equivalent (maximum weight percentage): 10
Available water capacity: High (about 9.2 inches)

Interpretive Groups
Land capability subclass (nonirrigated and irrigated): 3e
Meets hydric soil criteria: No
Hydrologic soil group: C

Vegetation
Existing plants: Western wheatgrass, bluebunch wheatgrass, big sagebrush, lomatium, other perennial forbs, other perennial grasses, little bluestem, and green needlegrass

Typical Profile
A—0 to 2 inches; silty clay loam
Bt—2 to 13 inches; silty clay
Bk—13 to 61 inches; silty clay loam

Minor Components

Heldt soils
Percent of map unit: 8 percent
Landform: Alluvial fans and hills
Geomorphic position (two-dimensional): Footslope
Representative aspect: North
Slope range: 4 to 8 percent
Down-slope shape: Linear
Across-slope shape: Linear
Meets hydric soil criteria: No

Midway soils
Percent of map unit: 7 percent
Landform: Hills
Geomorphic position (two-dimensional): Summit and shoulder
Representative aspect: North
Slope range: 2 to 8 percent
Down-slope shape: Linear
Across-slope shape: Linear
Meets hydric soil criteria: No

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils within Little Bighorn Battlefield National Monument. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help to prevent soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavioral characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils as rangeland and farmland and as sites for buildings, sanitary facilities, highways and other transportation systems, and recreational facilities. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the park. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, and trees and shrubs.

Interpretive Ratings

The interpretive tables in this survey rate the soils in the park for various uses. Many of the tables identify the limitations that affect specified uses and indicate the severity of those limitations. The ratings in these tables are both verbal and numerical.

Rating Class Terms

Rating classes are expressed in the tables in terms that indicate the extent to which the soils are limited by all of the soil features that affect a specified use or in terms that indicate the suitability of the soils for the use. Thus, the tables may show limitation classes or suitability classes. Terms for the limitation classes are *not limited, slightly limited, somewhat limited,* and *very limited*. The suitability ratings are expressed as *well suited, moderately well suited, poorly suited,* and *unsuited* or as *good, fair,* and *poor*.

Numerical Ratings

Numerical ratings in the tables indicate the relative severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.00 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact

on the use and the point at which the soil feature is not a limitation. The limitations appear in order from the most limiting to the least limiting. Thus, if more than one limitation is identified, the most severe limitation is listed first and the least severe one is listed last.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for forestland, or for engineering purposes.

In the capability system, soils are generally grouped at three levels—capability class, subclass, and unit (USDA-SCS, 1961). Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by the numbers 1 through 8. The numbers indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class 1 soils have slight limitations that restrict their use.

Class 2 soils have moderate limitations that restrict the choice of plants or that require moderate conservation practices.

Class 3 soils have severe limitations that restrict the choice of plants or that require special conservation practices, or both.

Class 4 soils have very severe limitations that restrict the choice of plants or that require very careful management, or both.

Class 5 soils are subject to little or no erosion but have other limitations, impractical to remove, that restrict their use mainly to pasture, rangeland, forestland, or wildlife habitat.

Class 6 soils have severe limitations that make them generally unsuitable for cultivation and that restrict their use mainly to pasture, rangeland, forestland, or wildlife habitat.

Class 7 soils have very severe limitations that make them unsuitable for cultivation and that restrict their use mainly to grazing, forestland, or wildlife habitat.

Class 8 soils and miscellaneous areas have limitations that preclude commercial plant production and that restrict their use to recreational purposes, wildlife habitat, watershed, or esthetic purposes.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, 2e. The letter *e* shows that the main hazard is the risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c,* used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class 1 there are no subclasses because the soils of this class have few limitations. Class 5 contains only the subclasses indicated by *w, s,* or *c* because the soils in class 5 are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, forestland, wildlife habitat, or recreation.

The capability classification of map units in this park is given in the section “Detailed Soil Map Units” and in table 2.

Prime and Other Important Farmland

Table 3 lists the map units in the park that are considered important farmlands. Important farmlands consist of prime farmland, unique farmland, and farmland of statewide or local importance. This list does not constitute a recommendation for a particular land use.

In an effort to identify the extent and location of important farmlands, the Natural Resources Conservation Service, in cooperation with other interested Federal, State, and local government organizations, has inventoried land that can be used for the production of the Nation's food supply.

Prime farmland is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for these uses. It could be cultivated land, pastureland, forestland, or other land, but it is not urban or built-up land or water areas. The soil quality, growing season, and moisture supply are those needed for the soil to economically produce sustained high yields of crops when proper management, including water management, and acceptable farming methods are applied. In general, prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, an acceptable salt and sodium content, and few or no rocks. The water supply is dependable and of adequate quality. Prime farmland is permeable to water and air. It is not excessively erodible or saturated with water for long periods, and it either is not frequently flooded during the growing season or is protected from flooding. Slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Natural Resources Conservation Service.

For some soils identified as prime farmland, measures that overcome a hazard or limitation, such as flooding, wetness, and droughtiness, are needed. Onsite evaluation is needed to determine whether or not the hazard or limitation has been overcome by corrective measures.

A recent trend in land use in some areas has been the loss of some prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, and less productive and cannot be easily cultivated.

Unique farmland is land other than prime farmland that is used for the production of specific high-value food and fiber crops, such as citrus, tree nuts, olives, cranberries, and other fruits and vegetables. It has the special combination of soil quality, growing season, moisture supply, temperature, humidity, air drainage, elevation, and aspect needed for the soil to economically produce sustainable high yields of these crops when properly managed. The water supply is dependable and of adequate quality. Nearness to markets is an additional consideration. Unique farmland is not based on national criteria. It commonly is in areas where there is a special microclimate, such as the wine country in California.

In some areas, land that does not meet the criteria for prime or unique farmland is considered to be *farmland of statewide importance* for the production of food, feed, fiber, forage, and oilseed crops. The criteria for defining and delineating farmland of statewide importance are determined by the appropriate State agencies. Generally, this land includes areas of soils that nearly meet the requirements for prime farmland and that economically produce high yields of crops when treated and managed according to acceptable farming methods. Some areas may produce as high a yield

as prime farmland if conditions are favorable. Farmland of statewide importance may include tracts of land that have been designated for agriculture by State law.

In some areas that are not identified as having national or statewide importance, land is considered to be *farmland of local importance* for the production of food, feed, fiber, forage, and oilseed crops. This farmland is identified by the appropriate local agencies. Farmland of local importance may include tracts of land that have been designated for agriculture by local ordinance.

Hydric Soils

Table 4 lists the map unit components that are rated as hydric soils in the park. This list can help in planning land uses; however, onsite investigation is recommended to determine the hydric soils on a specific site (National Research Council, 1995; USDA-NRCS, 2010).

The three essential characteristics of wetlands are hydrophytic vegetation, hydric soils, and wetland hydrology (Cowardin et al., 1979; U.S. Army Corps of Engineers, 1987; National Research Council, 1995; Tiner, 1985). Criteria for all of the characteristics must be met for areas to be identified as wetlands. Undrained hydric soils that have natural vegetation should support a dominant population of ecological wetland plant species. Hydric soils that have been converted to other uses should be capable of being restored to wetlands.

Hydric soils are defined by the National Technical Committee for Hydric Soils (NTCHS) as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register, 1994). These soils, under natural conditions, are either saturated or inundated long enough during the growing season to support the growth and reproduction of hydrophytic vegetation.

The NTCHS definition identifies general soil properties that are associated with wetness. In order to determine whether a specific soil is a hydric soil or nonhydric soil, however, more specific information, such as information about the depth and duration of the water table, is needed. Thus, criteria that identify those estimated soil properties unique to hydric soils have been established (Federal Register, 2002). These criteria are used to identify map unit components that normally are associated with wetlands. The criteria used are selected estimated soil properties that are described in “Soil Taxonomy” (Soil Survey Staff, 1999) and “Keys to Soil Taxonomy” (Soil Survey Staff, 2010) and in the “Soil Survey Manual” (Soil Survey Division Staff, 1993).

If soils are wet enough for a long enough period of time to be considered hydric, they should exhibit certain properties that can be easily observed in the field. These visible properties are indicators of hydric soils. The indicators used to make onsite determinations of hydric soils are specified in “Field Indicators of Hydric Soils in the United States” (USDA-NRCS, 2010).

Hydric soils are identified by examining and describing the soil to a depth of about 20 inches. This depth may be greater if determination of an appropriate indicator so requires. It is always recommended that soils be excavated and described to the depth necessary for an understanding of the redoximorphic processes. Then, using the completed soil descriptions, soil scientists can compare the soil features required by each indicator and specify which indicators have been matched with the conditions observed in the soil. The soil can be identified as a hydric soil if at least one of the approved indicators is present.

Map units that are dominantly made up of hydric soils may have small areas, or inclusions, of nonhydric soils in the higher positions on the landform, and map units dominantly made up of nonhydric soils may have inclusions of hydric soils in the lower positions on the landform.

The criteria for hydric soils are represented by codes in the table (for example, 2B3). Definitions for the codes are as follows:

1. All Histels except for Folistels and Histosols except for Folists.
2. Soils in Aquic suborders, great groups, or subgroups, Albolls suborder, Historthels great group, Histoturbels great group, Pachic subgroups, or Cumulic subgroups that:
   - A. are somewhat poorly drained and have a water table at the surface (0.0 feet) during the growing season, or
   - B. are poorly drained or very poorly drained and have either:
     - 1) a water table at the surface (0.0 feet) during the growing season if textures are coarse sand, sand, or fine sand in all layers within a depth of 20 inches, or
     - 2) a water table at a depth of 0.5 foot or less during the growing season if saturated hydraulic conductivity (K_{sat}) is equal to or greater than 6.0 in/hr in all layers within a depth of 20 inches, or
     - 3) a water table at a depth of 1.0 foot or less during the growing season if saturated hydraulic conductivity (K_{sat}) is less than 6.0 in/hr in any layer within a depth of 20 inches.
3. Soils that are frequently ponded for periods of long or very long duration during the growing season.
4. Soils that are frequently flooded for periods of long or very long duration during the growing season.

Ecological Sites

Plant communities are largely dependent on the soil, climate, topography, aspect, and slope of the landscape, as well as other abiotic features. To better understand these soil-plant interactions and the effects of selected management practices, the Natural Resources Conservation Service classifies forestlands and rangelands into ecological sites.

Landscapes of native vegetation are divided into ecological sites for the purposes of inventory, evaluation, and management. An ecological site, as defined for rangeland, is a distinctive kind of land with specific physical characteristics that differs from other kinds of land in its ability to produce a distinctive kind and amount of vegetation.

An ecological site is the product of all the environmental factors responsible for its development, including parent material, landscape, climate, soils, living organisms, hydrology, fire, and time in place. Ecological site descriptions contain information on each of these environmental factors. Included are brief descriptions of: a) physiographic and climatic features; b) major identifiable plant community types that may occupy the site, including the reference plant community; c) total annual production; d) ecological dynamics of the plant communities; e) soils and their main properties; and f) site interpretations and general management considerations for wildlife, hydrology, recreation, fire, esthetics, and restoration or revegetation.

The reference plant community for a site has evolved under natural ecological processes and disturbances and is considered to be at the highest natural site potential under the current climate. It has developed on the site as a result of all site-forming factors and is best adapted to the unique combination of environmental factors associated with the site. Natural disturbances, such as fire, drought, herbivory, and flooding, were inherent in the development and maintenance of the reference plant community. Plant communities that have been subject to anthropogenic disturbances or physical site deterioration or have been protected from the natural disturbances do not typify the reference state and may exist in a stable or steady state that is different from the reference plant community.

The reference plant community of an ecological site is not a precise assemblage of species for which the proportions are the same from place to place or from year to year. In all plant communities, the productivity and occurrence of individual species vary. Special boundaries of the communities can be recognized by characteristic

patterns of species composition, association, and community structure. Generally, one species or group of species dominates the site and the stability within the natural dynamics or disturbances of the site allows the species to be used as the factor that distinguishes one site from another.

At times, the extent of the less frequently occurring plants may increase on a site or plants not formerly occurring in the reference community may invade the site. The presence or abundance of these plants may fluctuate greatly because of the ability of the plants to adapt to the differences in the microenvironment, weather conditions, soil alterations, or human actions. Using these species for site identification can be misleading; thus they should not be used to differentiate sites.

The following ecological site inventory methods are used in determining the characteristic plant communities of an ecological site:

1. Identification and evaluation of reference and/or relict sites with similar plant communities and associated soils.
2. Interpolation and extrapolation of plant, soil, and climatic data from existing historic reference areas along a continuum to other points on that continuum for which no suitable reference community is available.
3. Evaluation and comparison of the same ecological site that occurs in different areas but that has experienced different levels of disturbance and management. Further comparison is made with areas that are not disturbed.
4. Evaluation and interpretation of research data dealing with the ecology, management, and soils in areas of the plant communities.
5. Review of historical accounts, survey and military records, and botanical literature of the areas.

The initial description of the reference state should be considered an approximation subject to modification as additional knowledge is gained or discovered.

Plant communities change along environmental gradients. When changes in soils, aspect, topography, or moisture conditions are abrupt, the plant community boundaries will be reasonably distinct. Boundaries are less distinct where the plant communities change gradually over wide environmental gradients of relatively uniform soils and topography. Thus, the need for site differentiation may not be readily apparent until the cumulative impact of soil, topography, hydrology, or climate is examined over a broad area. Frequently, such differences are reflected first in production and second in the kinds and proportions of a plant species making up the core of the plant community. In some cases, the boundaries that are drawn between ecological sites along a continuum of closely related soils and a gradually changing climate are somewhat arbitrary.

The following criteria are used to differentiate one ecological site from another:

1. Significant differences in the species or species groups that are in the characteristic plant community.
2. Significant differences in the relative proportion of species or species groups in the characteristic plant community.
3. Significant differences in the total annual production or site index of the characteristic plant community.
4. Soil factors that determine plant production and composition, the hydrology of the site, and the functioning of the ecological process of the water cycle, mineral cycles, and energy flow.

Differences in kind, proportion, and production of plants are the result of differences in soil, topography, climate, and other environmental factors. Slight variations in these factors are not criteria for site differentiation. Individual environmental factors are frequently associated with significant differences in reference plant communities. For differentiation into a distinct site to occur, the differences in the environmental factors must be great enough to affect the kinds, amounts, and proportions of the plant community.

Forestland is a spatially defined site where the reference community has at least 25 percent canopy cover. The reference community is the present-day climax community that most resembles the forest conditions prior to European contact. It developed with natural disturbances such as drought, fire, and insects. Several other plant communities may be present during the seral stages of development. Vegetation on forestland provides many habitat components, assists in controlling soil erosion, is suitable for grazing or browsing by wildlife, and offers scenic and recreational opportunities. Forestland is environmentally and economically important. For more information about NRCS national forestry policies, see the NRCS "National Forestry Manual," which is available online at http://soils.usda.gov/technical/nfmanual/.

The reference community for a rangeland ecological site does not have the potential to produce at least 25 percent canopy cover. Several other plant communities may be present during phases of development or altered conditions. Vegetation on rangeland provides many habitat components, assists in controlling soil erosion, is suitable for grazing or browsing by wildlife and domestic animals, and offers scenic and recreational opportunities. Rangeland is environmentally and economically important.

Table 5 lists the map unit symbol and each map unit component's name and percent of map unit alongside the ecological site name, ecological site type (forestland or rangeland), and ecological site number. Approved ecological site descriptions are available online at http://esis.sc.egov.usda.gov/. These descriptions are dynamic documents that are constantly updated as new research and data is gained; thus, the online version will be the most recent version of the descriptions.

Landscape, Parent Material, and Ecological Site

Table 6 displays information related to the ecological sites that are correlated to each soil in a map unit.

Percent of the map unit is the extent of the named soil in the map unit.

Slope is the inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance. The table shows the low and high range of slope for the named component or soil.

Elevation is the height of an object or area on the earth's surface in reference to a fixed reference point, such as mean sea level. The typical low and high range of elevation is displayed for each soil.

MAP is the mean annual precipitation for areas of the soil in the map unit.

Landscape refers to the broad shape of the earth in the area where the soil occurs. Examples are a valley and a mountain.

Landform is a specific shape of the earth in the area where a soil typically occurs. Examples are a mountain summit and a valley bottom.

Parent material is the material in which soils formed. Examples are the underlying geological material (including bedrock), a surficial deposit (such as volcanic ash), and organic material. Soils inherit their chemical and physical properties from the parent material.

Ecological site name and number is the ecological site name and unique reference number that are correlated to the named soil in the map unit.

Rangeland

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

Table 7 shows, for each soil that supports rangeland vegetation, the ecological site and the potential annual production of vegetation in favorable, normal, and unfavorable years. An explanation of the column headings in table 7 follows.

An *ecological site* is the product of all the environmental factors responsible for its development. It has characteristic soils that have developed over time throughout the soil development process; a characteristic hydrology, particularly infiltration and runoff, that has developed over time; and a characteristic plant community (kind and amount of vegetation). The hydrology of a site is influenced by development of the soil and plant community. The vegetation, soils, and hydrology are all interrelated. Each is influenced by the others and influences the development of the others. The plant community on an ecological site is typified by an association of species that differs from that of other ecological sites in the kind and/or proportion of species or in total production. Descriptions of ecological sites are provided in the “Field Office Technical Guide,” which is available in local offices of the Natural Resources Conservation Service.

Total dry-weight production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year’s growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In a normal year, growing conditions are about average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture. Yields are adjusted to a common percent of air-dry moisture content.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range similarity index and rangeland trend. Range similarity index is determined by comparing the present plant community with the potential natural plant community on a particular rangeland ecological site. The more closely the existing community resembles the potential community, the higher the range similarity index. Rangeland trend is defined as the direction of change in an existing plant community relative to the potential natural plant community. Further information about the range similarity index and rangeland trend is available in chapter 4 of the “National Range and Pasture Handbook,” which is available in local offices of the Natural Resources Conservation Service.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, control of undesirable brush species, conservation of water, and control of erosion. Sometimes, however, an area with a range similarity index somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

Land Management

In table 8, parts I through IV, interpretive ratings are given for various aspects of land management. The ratings are both verbal and numerical.

Some rating class terms indicate the degree to which the soils are suited to a specified land management practice. *Well suited* indicates that the soil has features that are favorable for the specified practice and has no limitations. Good performance can be expected, and little or no maintenance is needed. *Moderately suited* indicates that the soil has features that are moderately favorable for the specified practice. One

or more soil properties are less than desirable, and fair performance can be expected. Some maintenance is needed. *Poorly suited* indicates that the soil has one or more properties that are unfavorable for the specified practice. Overcoming the unfavorable properties requires special design, extra maintenance, and costly alteration. *Unsuited* indicates that the expected performance of the soil is unacceptable for the specified practice or that extreme measures are needed to overcome the undesirable soil properties.

Numerical ratings in the table indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the specified land management practice (1.00) and the point at which the soil feature is not a limitation (0.00).

Rating class terms for *fire damage* and *seedling mortality* are expressed as low, moderate, and high. Where these terms are used, the numerical ratings indicate gradations between the point at which the potential for fire damage or seedling mortality is highest (1.00) and the point at which the potential is lowest (0.00).

Rating class terms for *hazard of erosion* are expressed as slight, moderate, severe, and very severe. Where these terms are used, the numerical ratings indicate gradations between the point at which the potential for erosion is highest (1.00) and the point at which the potential is lowest (0.00).

The paragraphs that follow indicate the soil properties considered in rating the soils for land management practices.

Planting

Ratings in the columns *suitability for hand planting* and *suitability for mechanical planting* are based on slope, depth to a restrictive layer, content of sand, plasticity index, rock fragments on or below the surface, depth to a water table, and ponding. The soils are described as well suited, moderately suited, poorly suited, or unsuited to these methods of planting. It is assumed that necessary site preparation is completed before seedlings are planted.

Ratings in the column *soil rutting hazard* are based on depth to a water table, rock fragments on or below the surface, the Unified classification, depth to a restrictive layer, and slope. Ruts form as a result of the operation of planting equipment. The hazard is described as slight, moderate, or severe. A rating of *slight* indicates that the soil is subject to little or no rutting, *moderate* indicates that rutting is likely, and *severe* indicates that ruts form readily.

Hazard of Erosion and Suitability for Roads

Ratings in the column *hazard of erosion* are based on slope and on soil erodibility factor K. The soil loss is caused by sheet or rill erosion in areas where 50 to 75 percent of the surface has been exposed by different kinds of disturbance. The hazard is described as slight, moderate, severe, or very severe. A rating of *slight* indicates that erosion is unlikely under ordinary climatic conditions; *moderate* indicates that some erosion is likely and that erosion-control measures may be needed; *severe* indicates that erosion is very likely and that erosion-control measures, including revegetation of bare areas, are advised; and *very severe* indicates that significant erosion is expected, loss of soil productivity and off-site damage are likely, and erosion-control measures are costly and generally impractical.

Ratings in the column *hazard of erosion on roads and trails* are based on the soil erodibility factor K, slope, and content of rock fragments. The ratings apply to unsurfaced roads and trails. The hazard is described as slight, moderate, or severe. A rating of *slight* indicates that little or no erosion is likely; *moderate* indicates that some erosion is likely, that the roads or trails may require occasional maintenance, and that simple erosion-control measures are needed; and *severe* indicates that significant

erosion is expected, that the roads or trails require frequent maintenance, and that costly erosion-control measures are needed.

Ratings in the column *suitability for roads (natural surface)* are based on slope, rock fragments on the surface, plasticity index, content of sand, the Unified classification, depth to a water table, ponding, flooding, and the hazard of soil slippage. The ratings indicate the suitability for using the natural surface of the soil for roads. The soils are described as well suited, moderately suited, or poorly suited to this use.

Site Preparation

Ratings in the column *suitability for mechanical site preparation (deep)* are based on slope, depth to a restrictive layer, rock fragments on or below the surface, depth to a water table, and ponding. The soils are described as well suited, poorly suited, or unsuited to this management activity. The part of the soil from the surface to a depth of about 3 feet is considered in the ratings.

Ratings in the column *suitability for mechanical site preparation (surface)* are based on slope, depth to a restrictive layer, plasticity index, rock fragments on or below the surface, depth to a water table, and ponding. The soils are described as well suited, poorly suited, or unsuited to this management activity. The part of the soil from the surface to a depth of about 1 foot is considered in the ratings.

Site Restoration

Ratings in the column *potential for damage to soil by fire* are based on texture of the surface layer, content of rock fragments and organic matter in the surface layer, thickness of the surface layer, and slope. The soils are described as having a low, moderate, or high potential for this kind of damage. The ratings indicate an evaluation of the potential impact of prescribed fires or wildfires that are intense enough to remove the duff layer and consume organic matter in the surface layer.

Ratings in the column *potential for seedling mortality* are based on flooding, ponding, depth to a water table, content of lime, reaction, salinity, available water capacity, soil moisture regime, soil temperature regime, aspect, and slope. The soils are described as having a low, moderate, or high potential for seedling mortality.

Recreation

The soils of the park are rated in table 9, parts I and II, according to limitations that affect their suitability for recreation. The ratings are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect the recreational uses. *Not limited* indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. *Somewhat limited* indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. *Very limited* indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings in the table indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

The ratings in the table are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public

sewer lines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation also are important. Soils that are subject to flooding are limited for recreational uses by the duration and intensity of flooding and the season when flooding occurs. In planning recreational facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

The information in table 9 can be supplemented by other information in this survey, for example, interpretations for building site development, construction materials, and water management.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The ratings are based on the soil properties that affect the ease of developing camp areas and the performance of the areas after development. Slope, stoniness, and depth to bedrock or a cemented pan are the main concerns affecting the development of camp areas. The soil properties that affect the performance of the areas after development are those that influence trafficability and promote the growth of vegetation, especially in heavily used areas. For good trafficability, the surface of camp areas should absorb rainfall readily, remain firm under heavy foot traffic, and not be dusty when dry. The soil properties that influence trafficability are texture of the surface layer, depth to a water table, ponding, flooding, permeability, and large stones. The soil properties that affect the growth of plants are depth to bedrock or a cemented pan, permeability, and toxic substances in the soil.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The ratings are based on the soil properties that affect the ease of developing picnic areas and that influence trafficability and the growth of vegetation after development. Slope and stoniness are the main concerns affecting the development of picnic areas. For good trafficability, the surface of picnic areas should absorb rainfall readily, remain firm under heavy foot traffic, and not be dusty when dry. The soil properties that influence trafficability are texture of the surface layer, depth to a water table, ponding, flooding, permeability, and large stones. The soil properties that affect the growth of plants are depth to bedrock or a cemented pan, permeability, and toxic substances in the soil.

Foot traffic and equestrian trails for hiking and horseback riding should require little or no slope modification through cutting and filling. The ratings are based on the soil properties that affect trafficability and erodibility. These properties are stoniness, depth to a water table, ponding, flooding, slope, and texture of the surface layer.

Mountain bike and off-road vehicle trails require little or no site preparation. They are not covered with surfacing material or vegetation. Considerable compaction of the soil material is likely. The ratings are based on the soil properties that influence erodibility, trafficability, dustiness, and the ease of revegetation. These properties are stoniness, depth to a water table, ponding, slope, flooding, and texture of the surface layer.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. Ratings are given for building site development, landscaping, sanitary facilities, construction materials, and water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the “Soil Properties” section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil between the surface and a depth of 5 to 7 feet.

Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations should be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about particle-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 7 feet of the surface, soil wetness, depth to a water table, ponding, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kinds of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to evaluate the potential of areas for residential, commercial, and recreational uses; make preliminary estimates of construction conditions; evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; evaluate alternative sites for septic tank absorption fields and sewage lagoons; plan detailed onsite investigations of soils and geology; locate potential sources of gravel, sand, earthfill, and topsoil; plan drainage systems, ponds, and other structures for soil and water conservation; and predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil map, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Dwellings and Small Commercial Buildings

Soil properties influence the development of building sites, including the selection of the site, the design of the structure, construction, performance after construction, and maintenance. Table 10 shows the degree and kind of soil limitations that affect dwellings and small commercial buildings.

The ratings in the table are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect building site development. *Not limited* indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. *Somewhat limited* indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. *Very limited* indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings in the table indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

Dwellings are single-family houses of three stories or less. For dwellings without basements, the foundation is assumed to consist of spread footings of reinforced concrete built on undisturbed soil at a depth of 2 feet or at the depth of maximum frost penetration, whichever is deeper. For dwellings with basements, the foundation is assumed to consist of spread footings of reinforced concrete built on undisturbed soil at a depth of about 7 feet. The ratings for dwellings are based on the soil properties that affect the capacity of the soil to support a load without movement and on the properties that affect excavation and construction costs. The properties that affect the load-supporting capacity include depth to a water table, ponding, flooding, subsidence, linear extensibility (shrink-swell potential), and compressibility. Compressibility is inferred from the Unified classification. The properties that affect the ease and amount of excavation include depth to a water table, ponding, flooding, slope, depth to bedrock or a cemented pan, hardness of bedrock or a cemented pan, and the amount and size of rock fragments.

Small commercial buildings are structures that are less than three stories high and do not have basements. The foundation is assumed to consist of spread footings of reinforced concrete built on undisturbed soil at a depth of 2 feet or at the depth of maximum frost penetration, whichever is deeper. The ratings are based on the soil properties that affect the capacity of the soil to support a load without movement and on the properties that affect excavation and construction costs. The properties that affect the load-supporting capacity include depth to a water table, ponding, flooding, subsidence, linear extensibility (shrink-swell potential), and compressibility (which is inferred from the Unified classification). The properties that affect the ease and amount of excavation include flooding, depth to a water table, ponding, slope, depth to bedrock or a cemented pan, hardness of bedrock or a cemented pan, and the amount and size of rock fragments.

Roads and Streets, Shallow Excavations, and Landscaping

Soil properties influence the development of building sites, including the selection of the site, the design of the structure, construction, performance after construction, and maintenance. Table 11 shows the degree and kind of soil limitations that affect local roads and streets, shallow excavations, and landscaping.

The ratings in the table are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect building site development. *Not limited* indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. *Somewhat limited* indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. *Very limited* indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings in the table indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material; a base of gravel, crushed rock, or soil material stabilized by lime or cement; and a surface of flexible material (asphalt), rigid material (concrete), or gravel with a binder. The ratings are based on the soil properties that affect the ease of excavation and grading and the traffic-supporting capacity. The properties that affect the ease of excavation and

grading are depth to bedrock or a cemented pan, hardness of bedrock or a cemented pan, depth to a water table, ponding, flooding, the amount of large stones, and slope. The properties that affect the traffic-supporting capacity are soil strength (as inferred from the AASHTO group index number), subsidence, linear extensibility (shrink-swell potential), the potential for frost action, depth to a water table, and ponding.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for graves, utility lines, open ditches, or other purposes. The ratings are based on the soil properties that influence the ease of digging and the resistance to sloughing. Depth to bedrock or a cemented pan, hardness of bedrock or a cemented pan, the amount of large stones, and dense layers influence the ease of digging, filling, and compacting. Depth to the seasonal high water table, flooding, and ponding may restrict the period when excavations can be made. Slope influences the ease of using machinery. Soil texture, depth to the water table, and linear extensibility (shrink-swell potential) influence the resistance to sloughing.

Landscaping requires soils on which turf, trees, and shrubs can be established and maintained. Irrigation is not considered in the ratings. The ratings are based on the soil properties that affect plant growth and trafficability after vegetation is established. The properties that affect plant growth are reaction; depth to a water table; ponding; depth to bedrock or a cemented pan; the available water capacity in the upper 40 inches; the content of salts, sodium, or calcium carbonate; and sulfidic materials. The properties that affect trafficability are flooding, depth to a water table, ponding, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer.

Sewage Disposal

Table 12 shows the degree and kind of soil limitations that affect septic tank absorption fields and sewage lagoons. The ratings are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect these uses. *Not limited* indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. *Somewhat limited* indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. *Very limited* indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings in the table indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches or between a depth of 24 inches and a restrictive layer is evaluated. The ratings are based on the soil properties that affect absorption of the effluent, construction and maintenance of the system, and public health. Saturated hydraulic conductivity (K_{sat}), depth to a water table, ponding, depth to bedrock or a cemented pan, and flooding affect absorption of the effluent. Stones and boulders, ice, and bedrock or a cemented pan interfere with installation. Subsidence interferes with installation and maintenance. Excessive slope may cause lateral seepage and surfacing of the effluent in downslope areas.

Some soils are underlain by loose sand and gravel or fractured bedrock at a depth of less than 4 feet below the distribution lines. In these soils the absorption field may not adequately filter the effluent, particularly when the system is new. As a result, the ground water may become contaminated.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water. Considered in the ratings are slope, saturated hydraulic conductivity (K_{sat}), depth to a water table, ponding, depth to bedrock or a cemented pan, flooding, large stones, and content of organic matter.

Saturated hydraulic conductivity (K_{sat}) is a critical property affecting the suitability for sewage lagoons. Most porous soils eventually become sealed when they are used as sites for sewage lagoons. Until sealing occurs, however, the hazard of pollution is severe. Soils that have a K_{sat} rate of more than 14 micrometers per second are too porous for the proper functioning of sewage lagoons. In these soils, seepage of the effluent can result in contamination of the ground water. Ground-water contamination is also a hazard if fractured bedrock is within a depth of 40 inches, if the water table is high enough to raise the level of sewage in the lagoon, or if floodwater overtops the lagoon.

A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor. If the lagoon is to be uniformly deep throughout, the slope must be gentle enough and the soil material must be thick enough over bedrock or a cemented pan to make land smoothing practical.

Source of Gravel and Sand

Table 13 gives information about the soils as potential sources of gravel and sand. Normal compaction, minor processing, and other standard construction practices are assumed.

Gravel and *sand* are natural aggregates suitable for commercial use with a minimum of processing. They are used in many kinds of construction. Specifications for each use vary widely. Only the likelihood of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material. The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the Unified classification of the soil), the thickness of suitable material, and the content of rock fragments. If the bottom layer of the soil contains sand or gravel, the soil is considered a likely source regardless of thickness. The assumption is that the sand or gravel layer below the depth of observation exceeds the minimum thickness. The ratings are for the whole soil, from the surface to a depth of about 6 feet.

The soils are rated *good, fair,* or *poor* as potential sources of sand and gravel. A rating of *good* or *fair* means that the source material is likely to be in or below the soil. The bottom layer and the thickest layer of the soils are assigned numerical ratings. These ratings indicate the likelihood that the layer is a source of sand or gravel. The number 0.00 indicates that the layer is a poor source. The number 1.00 indicates that the layer is a good source. A number between 0.00 and 1.00 indicates the degree to which the layer is a likely source.

Source of Reclamation Material, Roadfill, and Topsoil

Table 14 gives information about the soils as potential sources of reclamation material, roadfill, and topsoil. Normal compaction, minor processing, and other standard construction practices are assumed.

The soils are rated *good, fair,* or *poor* as potential sources of reclamation material, roadfill, and topsoil. The features that limit the soils as sources of these materials are specified in the table. Numerical ratings between 0.00 and 0.99 are given after the

specified features. These numbers indicate the degree to which the features limit the soils as sources of topsoil, reclamation material, or roadfill. The lower the number, the greater the limitation.

Reclamation material is used in areas that have been drastically disturbed by surface mining or similar activities. When these areas are reclaimed, layers of soil material or unconsolidated geological material, or both, are replaced in a vertical sequence. The reconstructed soil favors plant growth. The ratings in the table do not apply to quarries and other mined areas that require an offsite source of reconstruction material. The ratings are based on the soil properties that affect erosion and stability of the surface and the productive potential of the reconstructed soil. These properties include the content of sodium, salts, and calcium carbonate; reaction; available water capacity; erodibility; texture; content of rock fragments; and content of organic matter and other features that affect fertility.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments. The ratings are for the whole soil, from the surface to a depth of about 5 feet. It is assumed that soil layers will be mixed when the soil material is excavated and spread.

The ratings are based on the amount of suitable material and on soil properties that affect the ease of excavation and the performance of the material after it is in place. The thickness of the suitable material is a major consideration. The ease of excavation is affected by large stones, depth to a water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the AASHTO classification of the soil) and linear extensibility (shrink-swell potential).

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area. The ratings are based on the soil properties that affect plant growth; the ease of excavating, loading, and spreading the material; and reclamation of the borrow area. Toxic substances, soil reaction, and the properties that are inferred from soil texture, such as available water capacity and fertility, affect plant growth. The ease of excavating, loading, and spreading is affected by rock fragments, slope, depth to a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, depth to a water table, rock fragments, depth to bedrock or a cemented pan, and toxic material.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Ponds and Embankments

Table 15 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas; embankments, dikes, and levees; and aquifer-fed excavated ponds. The ratings are both verbal and numerical. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect these uses. *Not limited* indicates that the soil has features that are very favorable for the specified use. Good performance and very low maintenance can be expected. *Somewhat limited* indicates that the soil has features that are moderately favorable for the specified use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. *Very limited* indicates that the soil has one or more features that are unfavorable for the specified use. The limitations generally cannot be overcome without major soil reclamation, special design, or

expensive installation procedures. Poor performance and high maintenance can be expected.

Numerical ratings in the table indicate the severity of individual limitations. The ratings are shown as decimal fractions ranging from 0.01 to 1.00. They indicate gradations between the point at which a soil feature has the greatest negative impact on the use (1.00) and the point at which the soil feature is not a limitation (0.00).

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the saturated hydraulic conductivity (K_{sat}) of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. Embankments that have zoned construction (core and shell) are not considered. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Aquifer-fed excavated ponds are pits or dugouts that extend to a ground-water aquifer or to a depth below a permanent water table. Excluded are ponds that are fed only by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Excavated ponds are affected by depth to a permanent water table, K_{sat} of the aquifer, and quality of the water as inferred from the salinity of the soil. Depth to bedrock and the content of large stones affect the ease of excavation.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey.

Soil properties are ascertained by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil map. Samples are taken from some typical profiles and tested in the laboratory to determine particle-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help to characterize key soils.

The estimates of soil properties are shown in tables. They include engineering properties, physical and chemical properties, and pertinent soil and water features.

Engineering Properties

Table 16 gives the engineering classifications and the range of engineering properties for the layers of each soil in the park.

Depth to the upper and lower boundaries of each layer is indicated.

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. “Loam,” for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is 15 percent or more, an appropriate modifier is added, for example, “gravelly.”

Classification of the soils is determined according to the Unified soil classification system (ASTM, 2005) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO, 2004).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to particle-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of particle-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement,

the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 10 inches in diameter and 3 to 10 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

Physical Soil Properties

Table 17 shows estimates of some physical characteristics and features that affect soil behavior. These estimates are given for the layers of each soil in the park. The estimates are based on field observations and on test data for these and similar soils.

Depth to the upper and lower boundaries of each layer is indicated.

Particle size is the effective diameter of a soil particle as measured by sedimentation, sieving, or micrometric methods. Particle sizes are expressed as classes with specific effective diameter class limits. The broad classes are sand, silt, and clay, ranging from the larger to the smaller.

Sand as a soil separate consists of mineral soil particles that are 0.05 millimeter to 2 millimeters in diameter. In this table, the estimated sand content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

Silt as a soil separate consists of mineral soil particles that are 0.002 to 0.05 millimeter in diameter. In this table, the estimated silt content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of sand, silt, and clay affects the physical behavior of a soil. Particle size is important for engineering and agronomic interpretations, for determination of soil hydrologic qualities, and for soil classification.

The amount and kind of clay affect the fertility and physical condition of the soil and the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, saturated hydraulic conductivity (K_{sat}), plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at $^1/_3$- or $^1/_{10}$-bar (33kPa or 10kPa) moisture tension. Weight is determined after the soil is dried at 105 degrees C. In the table, the estimated moist bulk density of each soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute linear extensibility, shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water

and roots. Depending on soil texture, a bulk density of more than 1.4 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability (K_{sat}) refers to the ability of a soil to transmit water or air. The term "permeability," as used in soil surveys, indicates saturated hydraulic conductivity (K_{sat}). The estimates in the table indicate the rate of water movement, in inches per hour, when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems and septic tank absorption fields.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each soil layer. The capacity varies, depending on soil properties that affect retention of water. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on the basis of measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The classes are *low,* a change of less than 3 percent; *moderate,* 3 to 6 percent; *high,* 6 to 9 percent; and *very high,* greater than 9 percent.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In this table, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter in a soil can be maintained by returning crop residue to the soil. Organic matter has a positive effect on available water capacity, water infiltration, soil organism activity, and tilth. It is a source of nitrogen and other nutrients for crops and soil organisms.

Erosion Properties

Table 18 shows estimates of some erosion factors that affect a soil's potential for different uses. These estimates are given for each layer of every soil for K factors and are given as one rating for the entire soil for the T factor, the wind erodibility group, and the wind erodibility index. Values are reported for each soil in the park. Estimates are based on field observations and on test data for these and similar soils.

Erosion factors are shown in the table as the K factor (Kw and Kf) and the T factor. Soil erosion factors Kw and Kf quantify soil detachment by runoff and raindrop impact. These erosion factors are indexes used to predict the long-term average soil loss from sheet and rill erosion under crop systems and conservation techniques. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and K_{sat}. Values

of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

The procedure for determining the Kf factor is outlined in Agriculture Handbook 703, “Predicting Soil Erosion by Water: A Guide to Conservation Planning with the Revised Universal Soil Loss Equation (RUSLE),” USDA, Agricultural Research Service, 1997.

Depth to the upper and lower boundaries of each layer is indicated.

Erosion factor Kw indicates the erodibility of the whole soil. The estimates are modified by the presence of rock fragments. In horizons where total rock fragments are 15 percent or more, by volume, the Kw factor is always less than the Kf factor.

Erosion factor Kf indicates the erodibility of the fine-earth fraction, or the material less than 2 millimeters in size. Soil horizons that do not have rock fragments are assigned equal Kw and Kf factors.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind and/or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their susceptibility to wind erosion in cultivated areas. The soils assigned to group 1 are the most susceptible to wind erosion, and those assigned to group 8 are the least susceptible. The groups are described in the “National Soil Survey Handbook.”

Wind erodibility index is a numerical value indicating the susceptibility of soil to wind erosion, or the tons per acre per year that can be expected to be lost to wind erosion. There is a close correlation between wind erosion and the texture of the surface layer, the size and durability of surface clods, rock fragments, organic matter, and a calcareous reaction. Soil moisture and frozen soil layers also influence wind erosion.

Total Soil Carbon

Table 19 gives estimates of total soil carbon. Soil carbon occurs as organic and inorganic carbon.

Soil organic carbon (SOC) is carbon (C) in soil that originated from a biological source, such as plants, animals, or micro-organisms. SOC is found in both organic and mineral soil layers. The term “soil organic carbon” refers only to the carbon occurring in soil organic matter (SOM). Soil organic carbon makes up about one-half the weight of soil organic matter. The rest of SOM is mostly oxygen, nitrogen, and hydrogen.

Soil inorganic carbon (SIC) is carbon found in soil carbonates, typically as calcium carbonate layers in the soil or as clay-sized fractions throughout the soil. Carbonates in soils are most common in areas where evaporation rates exceed precipitation, as is the case in most desert environments. Typically, the carbonates accumulated from carbonatic dust or from solution during periods of wetter climates. Soil inorganic carbon also occurs in soils that formed in marl in all regions of the country.

The SOC and SIC contents are reported in kilograms per square meter to a depth of 2 meters or to a representative depth of either hard bedrock or a cemented horizon. The SOC and SIC values are on a whole soil basis, corrected for rock fragments.

SOC can be an indicator of overall soil fertility and soil quality that affects ecosystem function. SOM is the main reservoir for most plant nutrients, such as phosphorus and nitrogen. Managing for SOC by managing for SOM increases the content of these elements and improves soil resiliency.

Soil organic matter binds soil particles together and thus increases soil porosity and water infiltration and allows better root penetration and waterflow into the soil. Greater inflow of water reduces the hazard of erosion and the rate of surface water runoff.

Greater SOC levels improve not only soil quality but also the quality of air and water. Soil acts as a filter and improves water quality. Fertile soils that support plant life remove CO_2 from the atmosphere and increase oxygen levels through photosynthesis. Maintaining the level of soil organic carbon reduces C release into the atmosphere and thus can lessen the effects of global warming.

SIC influences the types of plants that will grow. High SIC levels are commonly associated with a higher soil pH, which limits the types of plants that will thrive.

Like SOM, soil carbonates, the source of SIC, also bind soil particles together. They fill voids in the soil and thus can reduce soil porosity. Compacted soil carbonates may restrict root penetration and waterflow into the soil.

Chemical Soil Properties

Table 20 shows estimates of some chemical characteristics and features that affect soil behavior. These estimates are given for the layers of each soil in the park. The estimates are based on field observations and on test data for these and similar soils.

Depth to the upper and lower boundaries of each layer is indicated.

Cation-exchange capacity is the total amount of extractable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. Soils having a low cation-exchange capacity hold fewer cations and may require more frequent applications of fertilizer than soils having a high cation-exchange capacity. The ability to retain cations reduces the hazard of ground-water pollution.

Soil reaction is a measure of acidity or alkalinity. The pH of each soil horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Calcium carbonate equivalent is the percent of carbonates, by weight, in the fraction of the soil less than 2 millimeters in size. The availability of plant nutrients is influenced by the amount of carbonates in the soil.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Sodium adsorption ratio (SAR) is a measure of the amount of sodium (Na) relative to calcium (Ca) and magnesium (Mg) in the water extract from saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration. Soils that have SAR values of 13 or more may be characterized by an increased dispersion of organic matter and clay particles, reduced saturated hydraulic conductivity (K_{sat}) and aeration, and a general degradation of soil structure.

Water Features

Table 21 gives estimates of various soil water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained

soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas.

The *months* in the table indicate the portion of the year in which a water table, ponding, and/or flooding is most likely to be a concern.

Water table refers to a saturated zone in the soil. Table 21 indicates, by month, depth to the top (*upper limit*) and base (*lower limit*) of the saturated zone in most years. Estimates of the upper and lower limits are based mainly on observations of the water table at selected sites and on evidence of a saturated zone, namely grayish colors or mottles (redoximorphic features) in the soil. A saturated zone that lasts for less than a month is not considered a water table.

Ponding is standing water in a closed depression. Unless a drainage system is installed, the water is removed only by percolation, transpiration, or evaporation. The table indicates *surface water depth* and the *duration* and *frequency* of ponding. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, *long* if 7 to 30 days, and *very long* if more than 30 days. Frequency is expressed as none, rare, occasional, and frequent. *None* means that ponding is not probable; *rare* that it is unlikely but possible under unusual weather conditions (the chance of ponding is nearly 0 percent to 5 percent in any year); *occasional* that it occurs, on the average, once or less in 2 years (the chance of ponding is 5 to 50 percent in any year); and *frequent* that it occurs, on the average, more than once in 2 years (the chance of ponding is more than 50 percent in any year).

Flooding is the temporary inundation of an area caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, and water standing in swamps and marshes is considered ponding rather than flooding.

Duration and *frequency* are estimated. Duration is expressed as *extremely brief* if 0.1 hour to 4 hours, *very brief* if 4 hours to 2 days, *brief* if 2 to 7 days, *long* if 7 to 30 days, and *very long* if more than 30 days. Frequency is expressed as none, very rare, rare, occasional, frequent, and very frequent. *None* means that flooding is not probable; *very rare* that it is very unlikely but possible under extremely unusual weather conditions (the chance of flooding is less than 1 percent in any year); *rare* that it is unlikely but possible under unusual weather conditions (the chance of flooding is 1 to 5 percent in any year); *occasional* that it occurs infrequently under normal weather conditions (the chance of flooding is 5 to 50 percent in any year); *frequent* that it is likely to occur often under normal weather conditions (the chance of flooding is more than 50 percent in any year but is less than 50 percent in all months in any year); and *very frequent* that it is likely to occur very often under normal weather conditions (the chance of flooding is more than 50 percent in all months of any year).

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and little or no horizon development.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of

flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

Soil Features

Table 22 gives estimates of various soil features. The estimates are used in land use planning that involves engineering considerations.

A *restrictive layer* is a nearly continuous layer that has one or more physical, chemical, or thermal properties that significantly impede the movement of water and air through the soil or that restrict roots or otherwise provide an unfavorable root environment. Examples are bedrock, cemented layers, dense layers, and frozen layers. *Depth to top* is the vertical distance from the soil surface to the upper boundary of the restrictive layer.

Potential for frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, saturated hydraulic conductivity (K_{sat}), content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured, clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that corrodes or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors results in a severe hazard of corrosion. The steel or concrete in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than the steel or concrete in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low, moderate,* or *high,* is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion also is expressed as *low, moderate,* or *high.* It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Formation and Classification of the Soils

This section relates the soils in Little Bighorn Battlefield National Monument to the major factors of soil formation and describes the system of soil classification.

Factors of Soil Formation

By Susan Burlew Southard, Natural Resources Conservation Service.

Soil covers the surface of the earth as a three-dimensional body of varying thickness and is made up of different proportions of organic and mineral material, pore space with gases, and water. Soils differ in their appearance, productivity, and management requirements due to their chemical and physical properties. The characteristics and properties of soils are determined by physical and chemical processes that result from the interaction of five soil-forming factors. These factors of soil formation are interdependent, and few generalizations can be made regarding any one factor unless the effects of the other factors are known. The term “pedogenesis” is often used to connote the processes of soil formation.

The interacting soil-forming factors are parent material, climate, organisms, time, and relief or topography (Jenny, 1941). *Parent material* is the source material in which soils formed. Soils are influenced by the texture and structure of the parent material and its mineralogical and chemical composition. *Climate* is predominantly the temperature and kind and amount of precipitation. It is also seasonal distribution of temperature and precipitation. *Organisms* are the plants and other organisms living in and on the soil, including humans. *Time* refers to how long the soil-forming factors have been operating on a particular landscape. *Relief* or *topography* is the shape and elevation of the landscape. It affects internal and external soil properties, such as soil drainage, aeration, susceptibility to erosion, and the soil’s exposure to the sun and wind.

The processes of soil formation are a sequence of events, involving biogeochemical reactions that are energized by climate and spatially related to relief or topography (Buol et al., 2011). The physical and chemical properties of a soil are altered by these reactions over time. The influence of any one of these factors varies among all parks and within localities of a particular park. Soils may differ significantly from place to place in a park and within very short distances as a result of complex interaction among the five factors. In some cases, however, parks may have vast stretches of the same type of soil because of uniform soil-forming factors.

Setting of Little Bighorn Battlefield National Monument

Understanding the setting of the park helps in understanding the parent materials contributing to the types of soils within it. Understanding the soils of southeastern Montana also helps in understanding the unique relationship between soils and the environment. Soil-forming processes are influenced by rock type, topographic expression, and the hydrologic properties of the area. These processes influence soil properties and behavior, which can help to determine best management practices.

Little Bighorn Battlefield National Monument (Little Bighorn BNM) is located in southeastern Montana on the western edge of the Great Plains. It is within the

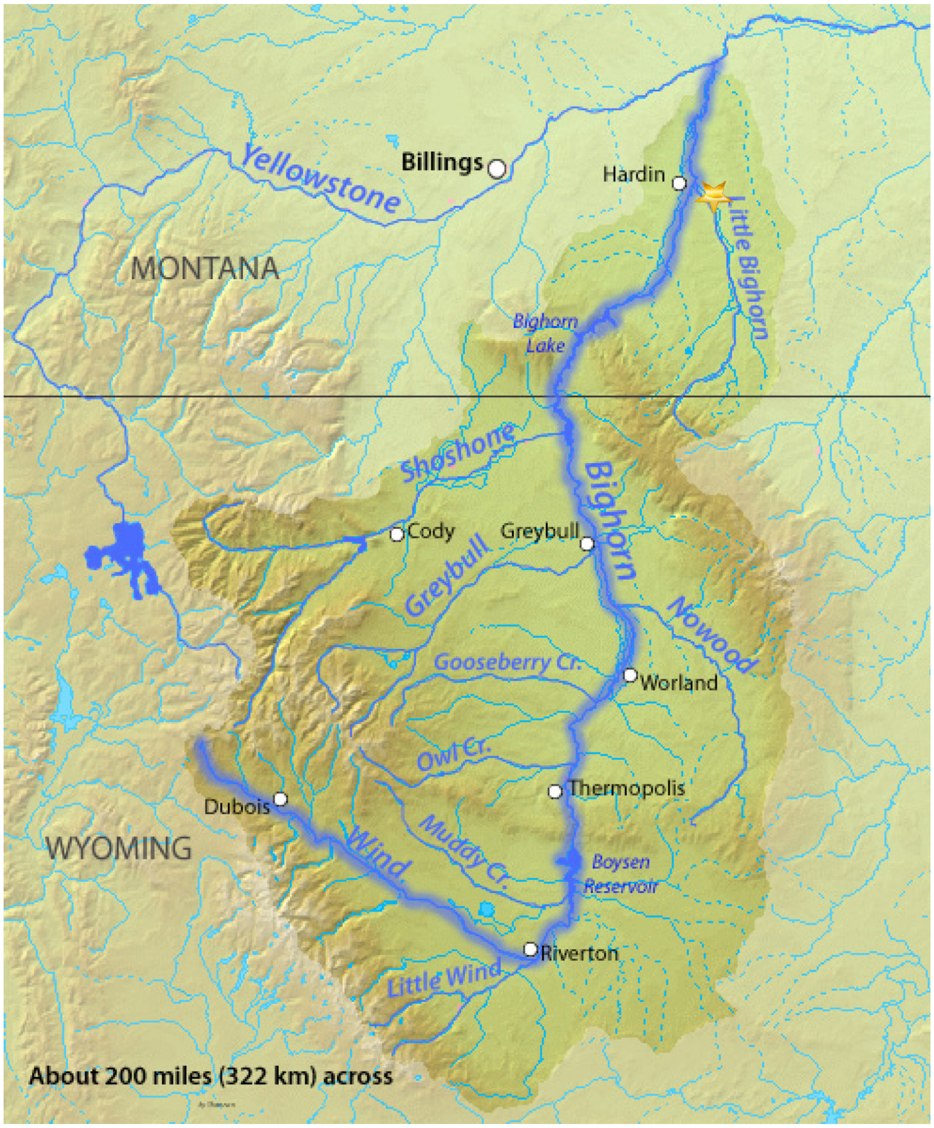

Figure 1.—Location of Little Bighorn Battlefield National Monument in relation to the Bighorn River watershed in Wyoming and Montana. The gold star indicates the approximate location of the park. Graphic was compiled by Susan Burlew Southard (NRCS). Base map was created by Shannon1 using DEMIS Mapserver (http://en.wikipedia.org/wiki/File:Bighornrivermap.jpg).

watershed of the Bighorn River (fig. 1). The national monument overlooks the lower Little Bighorn River valley. The headwaters of the Little Bighorn River are in the Wolf Mountains to the south. Surrounding the monument is the Crow Indian Reservation.

Various landforms dominate the landscape of the park. The landscape consists of a series of ridges dissected by ravines and coulees. “Coulee” is a French term used the western United States to indicate a small intermittent stream (or the bed of a stream) (KellerLynn, 2011). During the Battle of the Little Bighorn, ridges provided views across the broad valley and defensible high ground for soldiers of the 7th Cavalry. Ravines and coulees, which cut into the ridges, allowed for the secluded advance of Indian attackers. The steep banks on the east side of the Little Bighorn River form an abrupt edge, limiting access to and from the flood plain (KellerLynn, 2011). Stream terraces

line the west side of the Little Bighorn River valley. Flat-topped terraces with well drained soils directly above the Little Bighorn River served as suitable campgrounds for the warriors and their families at the time of the battle.

The High Plains of eastern Montana make up a broad area that has slowly been uplifting for the past 5 million years. The regional uplift was due to the mountain building and subsequent erosion of the Rocky Mountains to the west. This resulted in a rebound effect (the area rose in elevation) to the east in the High Plains. As the plains rose in elevation, rivers cut through them. New source materials for soil formation were created as rivers and streams that meandered across the landscape carrying eroded sediments cut into and eroded local geologic formations. The rivers then deposited new unconsolidated sediments known as alluvium. The bedrock formations exposed in the park are primarily shale and sandstone of Upper Cretaceous age (99.6 million to 65.5 million years ago) and include the Bearpaw Formation and the Judith River Formation (KellerLynn, 2011). These formations were part of the Cretaceous Interior Seaway and were deposited during that time (fig. 2). The river channel consists of Pleistocene (2.6 million to 11,700 years ago) terrace deposits and Holocene (the past 11,700 years) river deposits (KellerLynn, 2011). The landscape is a result of fluvial processes, mainly river downcutting, and redeposition of alluvial deposits that became the parent material for an array of different soils.

The Little Bighorn River meanders back and forth across the landscape, creating abandoned stream channels called oxbows. The increasing sinuosity of the channel as it meanders downstream is a result of changes in the local gradient, sediment particle size of the flood-plain deposits, and conditions of riparian vegetation (Beschta, 1998). The sediment particle size and organic matter accumulation (from decaying vegetation) influence the soils that form from the sediment of the plants. Generally, coarse substrates underlie fine textured soils associated with the Little Bighorn riverbank and flood plain (Beschta, 1998).

Parent Material

The unconsolidated mass in which soils form is called parent material. Mineral soils are a product of the weathering in place of underlying bedrock or the weathering of material that has been transported. Organic soils form in place from the accumulation and decomposition of plant material, such as wood, leaves, and aquatic plants. Weathering refers to the chemical and physical disintegration and decomposition of parent material. Few soils weather entirely from the underlying rocks. More commonly, soils form in materials that have been moved from elsewhere. Soils generally have a dominant kind of parent material but are influenced by other types of parent material. Material may have been moved by gravity (colluvial parent material) or transported long distances by wind (eolian parent material) or water (alluvial parent material). Soils are said to have residual parent material if they formed directly from underlying rocks or from an *in situ* plant source. Soils that formed in residuum may have the same general chemistry as the original rocks, depending on the degree of weathering that has occurred.

The soils of Little Bighorn BNM formed predominantly from 1) alluvium, 2) a combination of residuum and colluvium, or, 3) a combination of eolian and alluvial materials.

Alluvium is the type of soil parent material deposited by running water. It can have different textures, depending on whether the water moves quickly or slowly. The type of rocks occurring in the source region of the streams and rivers also determine its characteristics. Fast-moving water deposits gravel, rocks, and sand. Slow-moving water leaves fine textured deposits (clay and silt) when sediments in the water settle out. Most of the alluvium from which soils in the park have formed is clayey or silty, having been derived from the sedimentary rocks of the Bearpaw and Judith River Formations. Examples of alluvial soils in the park are Clapper, Haverson, Glenberg,

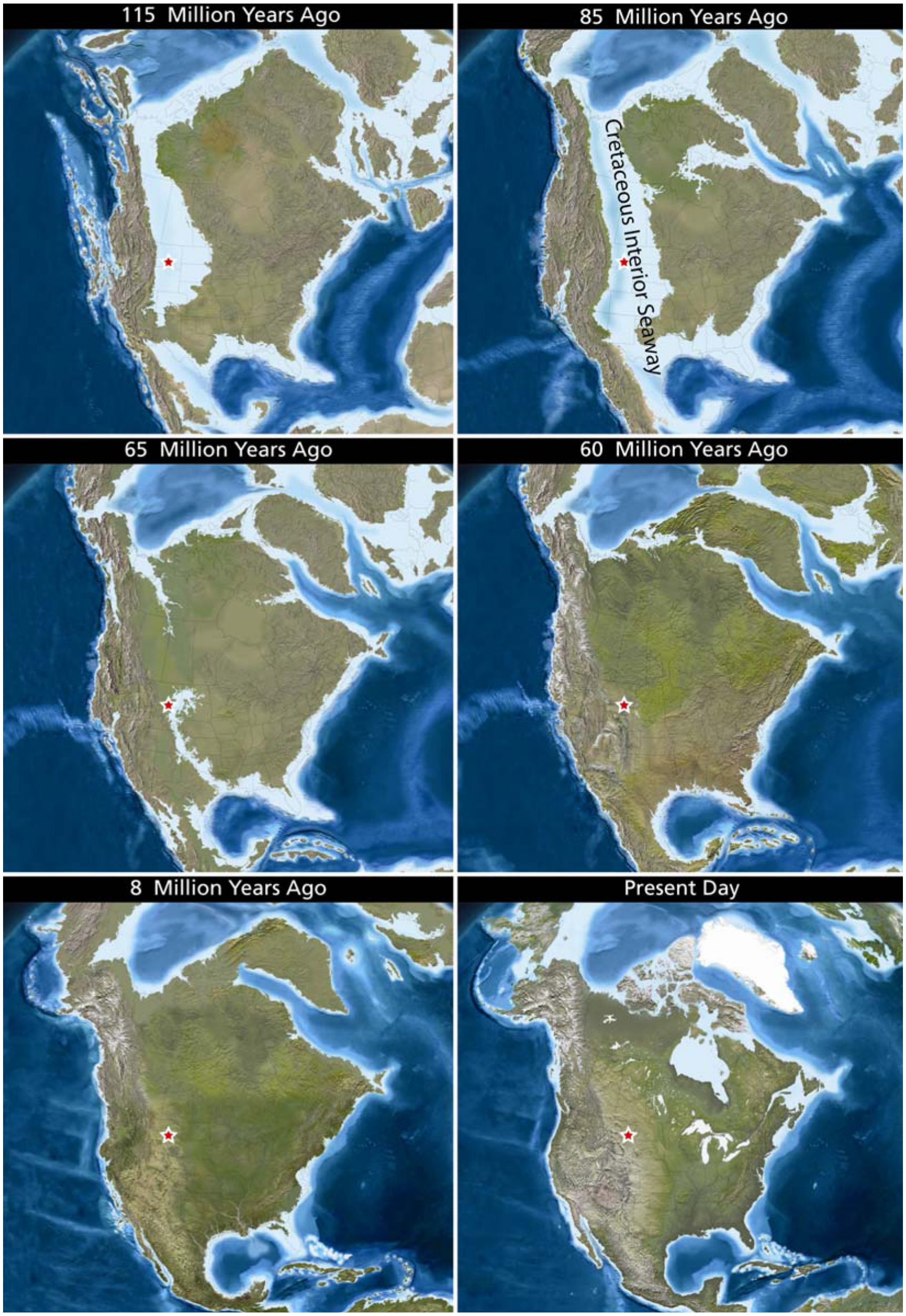

Figure 2.— Location of Little Bighorn Battlefield National Monument relative to the major seaway that dissected the middle part of United States over the past 85 million years. The stars on the figure represent the approximate locations of the survey area during various points of geologic time. Graphic was complied by Phil Reiker (NPS Geologic Resources Division). Base paleogeographic maps were created by Ron Blakey (Northern Arizona University) and are available at http://jan.ucc.nau.edu/~rcb7/index.html.

Heldt, and Thurlow. All of these soils are associated with the flood plain and river terraces of the Little Bighorn River. Haverson and Glenberg soils are mapped on Holocene alluvial deposits in the lowest positions on the river terraces, less than 6 feet above the river (fig. 3). These soils are along the meanders of the river. This landscape position floods occasionally (see table 21). Thurlow soils also formed in alluvium and are on alluvial fan terraces and river terraces on both sides of the Little Bighorn River. Areas mapped as Thurlow are just north of the Garryowen Historical marker along the I-90 frontage road and on the opposite side of the river at the Custer National Cemetery (fig. 4). Heldt soils are mapped as an inclusion in map units that are predominantly Midway soils. Heldt soils lie on footslopes below the Greasy Grass Ridge.

Clapper soils are mapped on a paleoterrace above the Greasy Grass Ridge in the very northwest corner of the Custer National Cemetery park unit. A paleoterrace is formed by the downcutting of an old, abandoned flood plain. The paleoterraces in Little Bighorn BNM are at the highest points on the landscape. Clapper soils are well developed and have layers (or soil horizons) of calcium carbonate accumulation and thick carbonate coatings on rocks within the soil profile. These soils have more soil inorganic carbon (SIC) sequestered in their horizons than any other soil in the park (see table 19). Soil inorganic carbon is carbon found in soil carbonates, usually as calcium carbonate layers in the soil or as clay-sized fractions throughout the soil. Carbonates in soils occur in areas where evaporation rates exceed precipitation, as is the case in most arid and semiarid environments. Usually the carbonates accumulated

Figure 3.—Relationships of soils to landscape positions along the Little Bighorn River. Soils on the lowest terraces and flood plains are Haverson and Glenberg. Meanders of the river cut into higher terraces and toeslopes of alluvial fans that are commonly mapped as Heldt and Lohmiller soils.

Figure 4.—The Custer National Cemetery is mapped as Thurlow silty clay loam, 4 to 8 percent slopes. Thurlow soils are very deep and well drained and formed in calcareous clay loam from unconsolidated materials.

from carbonatic dust or from solution when wetter climates existed. Carbonate C is measured by treating the soil with HCl, then measuring the evolved CO_2 with a manometer. Based on soil survey data, the soil carbon in Clapper soils is mostly in the inorganic form of calcium carbonate and makes up 27 kg/m^2 (or 120 tons/acre), which exceeds the organic form by 7 times.

The degree of profile development in Clapper soils suggests that river downcutting has been an ongoing process for hundreds of thousands of years. The cessation of active fluvial processes provided landscape stability which allowed certain soil features to develop over time. Clapper soils are very gravelly, indicating that the water that deposited the alluvium was of much higher energy than that of other alluvium-derived soils in the park.

Soils that formed from residuum and colluvium include Pierre and Midway. Midway soils are one of the most dominant soils in the park, occurring on hillslopes and summits. These soils are mapped on Greasy Grass Ridge, on Battle Ridge, in Deep Ravine, and along Battlefield Road (fig. 5). They formed in residuum and colluvium derived from shale, are shallow to weathered shale, and have a soft bedrock contact, or what soil scientists refer to as a paralithic contact, at a depth of 10 to 20 inches. Pierre soils are similar to Midway but are deeper with the paralithic contact at a depth to 20 to 40 inches (see table 22). Pierre soils are mapped exclusively in the Reno-Benteen Battlefield area. These soils are very clayey with a uniformly high clay content throughout the profile (see table 17). Midway and Pierre soils, as well as Allentine, Heldt, Hesper, Hydro, Kyle, Lismas, Lohmiller, Norbert, and Thurlow, have a very high clay content with a high shrink-swell potential (see table 17). These soils expand or swell when wet and shrink when dry (fig. 6). This is because of the type of clay mineral that makes up the clay-sized particles—smectite. Smectitic soils are commonly limited for uses such as building sites (see table 10) and are identified in table 23 as having smectitic mineralogy. The shrinking and swelling of smectitic soils can be strong enough to cause foundations to move and crack, sidewalks to heave, and infrastructures to break.

In the case here, the smectite was inherited from the shale parent material. Smectitic soils commonly have cracking of the soil surface that can be observed during dry seasons, but cracks can also form within the soil. When the soils are moist, the cracks close. These clayey soils are very slippery on the surface when moist or wet and have a very sticky, greasy feel. Lakota and Cheyenne warriors termed their attack on the U.S. Army’s 7th Cavalry the “Battle of Greasy Grass,” and once can only speculate that was because of the dew-moistened smectitic soils they crawled over to position themselves for the attack.

Loess is a type of parent material that has been blown for long distances. It consists mainly of silt-sized particles. It is common in parks of the Midwest. For thousands of years, the High Plains have had a prevalent northwesterly wind pattern that continues today. In the park, Hesper soils formed in alluvium and loess. These soils are silty and calcareous and occur on the highest paleoterraces of the Little Bighorn River. The paleoterraces mapped as Hesper soils lie above the Greasy Grass Ridge and southwest of the Visitor Center. These paleoterraces were draped by loess being blown out of the ancestral interior seaway that eventually dried up, exposing the weatherable sedimentary materials. Most of the Pleistocene-age to present-day contributions of loess are probably from the Little Bighorn River valley.

The influence of parent material on soil is commonly a major factor in the development of ecological niches in a park. The influence of parent material on soil depth and soil chemistry helps to determine the types of vegetation in specific areas. For example, Havre and Haverson soils are silty soils that support a specific ecological site. The ecological site R058AE001MT has a certain plant community containing a high diversity of tall and medium height, cool- and warm-season grasses (green needlegrass, bluebunch wheatgrass, western wheatgrass, needle and thread, little bluestem, and sideoats grama) and short grasses and sedges (Sandberg bluegrass, plains muhly, prairie junegrass, threadleaf sedge, and blue grama). It also has abundant forbs and shrubs that occur in small percentages, including dotted

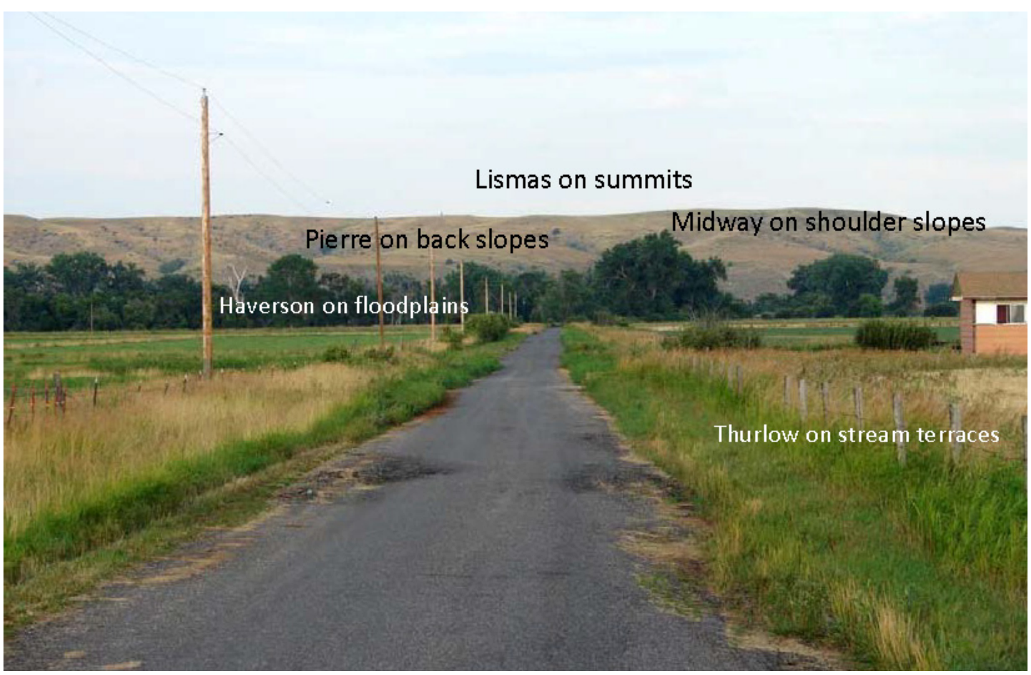

Figure 5.—Relationship of soils to landscape positions as viewed looking east from Garryowen. Battlefield Road is on the high landscape in the distance.

Figure 6.—Soils in the park with smectitic mineralogy are common (see table 23) and form surface cracks when dry. Smectitic clays in the park are inherited from the soil parent material and have a high shrink-swell potential.

gayfeather, black samson, purple prairieclover, white prairieclover, winterfat, Nuttall's saltbush, silver sagebrush, and Wyoming big sagebrush. This plant community is well adapted to the climate of the Northern Great Plains. Because of the diversity in plant species and the presence of tall, deep-rooted, perennial grasses, area vegetation can withstand periods of drought. Individual species can vary greatly in production depending on growing conditions (timing and amount of precipitation and temperature). Plants on this site have strong, healthy root systems that allow production to increase significantly with favorable precipitation. The abundant plant litter helps in soil building and moisture retention. Runoff from adjacent sites and a high available water capacity provide a favorable soil-water-plant relationship. This plant community provides for high soil stability, carbon accumulation at depth, and a well functioning hydrologic cycle.

Climate

Differences in climate can result in differences in soils. Temperature and moisture influence soil formation and are the two most commonly measured features of soil

climate. Weathering is most active when soils are moist and warm because these soil conditions are conducive to rapid chemical reactions and increased biological activity in the soil. Cooler soil temperatures result in slower chemical reactions. While average temperatures and precipitation are important in determining soil properties, the extremes of climate in any given locale also play a major role in soil formation.

Wind redistributes sand, salts, carbonates, and other particles in parks of arid and semiarid regions. The soils of Little Bighorn BNM formed in, and are still forming in, a dry climate with limited precipitation. Some of the soils, such as Haverson and Glenberg, are calcareous to the surface because there is not enough rainfall to leach the carbonates from the soil and because winds constantly add more carbonates to the soil. During periods of rainfall or snowmelt, water carrying dissolved or suspended solids moves through soil in a process called leaching. Leaching becomes active with the onset of rainfall or snowmelt. Because of the arid climate, leaching processes in Little Bighorn BNM are very limited.

Present-day climate variations are the result of topography and relief. In most areas of the United States, temperature generally decreases with elevation and precipitation generally increases with elevation. As the amount of precipitation increases, the extent of leaching and the amount of vegetation generally increase to a point where they then decrease because of decreasing temperatures. Fluctuations in temperature and moisture amounts affect the rate of organic matter production, decomposition, and accumulation and the weathering of minerals. Due to its small size, the park has a fairly uniform climatic regime overall.

In general, most of the northern part of the Great Plains encompassing Little Bighorn BNM has an average of 10 to 14 inches of total precipitation annually. Typically, 80 percent occurs during the April to September growing season. Snowfall is typically not heavy, but slightly heavier amounts occur in the uplands. Heavy snowfall occurs infrequently, usually in late winter or early spring. Sunshine prevails 70 to 80 percent of the summer, with interruptions mostly during the afternoons from occasional rain showers and thunderstorms. Spring is usually the windiest time of the year, with winds averaging more than 20 miles per hour about 15 percent of the time. Winds with speeds of 50 miles per hour or more occasionally occur when a weather system crosses the State. The growing season (period when freezing does not occur) averages about 100 to 125 days. Temperatures are extreme, ranging from approximately 45 degrees F below zero to nearly 110 degrees F above. Temperatures can reach 90 degrees F or more anytime between May and September. Winters are cold; several days of below zero temperatures occur each year.

Soils on stable landforms, such as Clapper and Hesper soils on paleoterraces, have been affected by climatic conditions different from those of today (a paleoclimate). These relict soils are termed paleosols. They have distinct morphological features resulting from a soil-forming environment that no longer exists on the site. In Clapper soils, calcium carbonates have been moved deeper into the profile through leaching and are of a higher concentration that what would be expected given the precipitation of the area today. The distribution of silts in Hesper soils suggests that the soils were influenced by strong directional winds that deposited higher amount of silt than would be deposited today.

Organisms

Plants, animals, micro-organisms, and humans affect the formation and shape of soils. Plants capture solar energy via photosynthesis and transfer that energy to the soil, energy that is a fundamental driver of many soil processes. Fungi and bacteria are the primary organisms that decompose organic matter and add nutrients to the soil. Animals and micro-organisms mix soils and form burrows and pores. Plant roots open channels in the soils. Abandoned animal burrows commonly are filled with

loose material from the overlying horizons and transmit water more readily than the surrounding undisturbed soil material.

Different types of roots have different effects on soils. Grass roots are fibrous and decompose easily, adding organic matter to the soil. Fine grass roots can extend below the surface for many feet. Plant roots also help to develop soil structure and aggregate stability. Vegetation increases soil stability by protecting the surface against wind and water erosion. Taproots open pathways through dense layers. Micro-organisms affect chemical exchanges between roots and soil. Humans also can mix the soil extensively.

Thurlow soils formed in calcareous alluvium and have a dark surface color due to organic matter accumulation. These soils are on alluvial fans where organic matter has accumulated because of higher plant productivity due to water concentration from the surrounding areas. They have the highest content of soil organic carbon (SOC) of any soil in the park (see table 19). Soil organic carbon makes up about one-half the weight of soil organic matter. Soil organic carbon is carbon (C) in soil that originated from a biological source, such as plants, animals, or micro-organisms. SOC refers only to the carbon occurring in soil organic matter. Thurlow soils have 12 kg/m^2 of SOC, which equates to 53 tons of SOC per acre.

SOC is found in organic and mineral layers of the soil. Soil layers are referred to as “horizons” by soil scientists. Soil horizons named O, A, or B have high levels of organic carbon and a very low mineral content, and those named C typically have the least amount of soil organic carbon and a high mineral content.

Root growth and humification of organic matter can darken soils to considerable depths. Humification occurs when micro-organisms decompose leaves, wood, roots, and animals and convert them into humic substances. Humic substances are broadly defined products of organic matter decomposition that are relatively resistant to further microbial decomposition. Humic substances with a high carbon content can persist in the soil for a long time (hundreds to thousands of years). Some examples of humic substances are humic and fulvic acids and humins. Humification is common in prairies where there is prolific root growth of native grasses. Native grasses contributed to the organic matter content of the soils in upland positions in the park.

The native vegetation depends on climate, topography, and biological factors plus many soil factors, such as soil density, depth, chemistry, temperature, and moisture. Leaves from plants fall to the surface. Organisms decompose these leaves and mix them within the upper part of the soil, resulting in the cycling of nutrients and energy back to vegetation.

Time

Time for parent material, climate, organisms, and topography to interact with the soil is also a soil-forming factor. Over time, soils exhibit features that reflect the interaction of other soil-forming factors. Recently deposited material, such as material deposited by a flood, exhibits no features from soil development activities and its properties are mostly inherited from the new material. The previous soil surface and underlying horizons become buried. The time clock resets for these soils. The different horizons in a soil profile and the degree of development can be directly related to time. Terraces above the active flood plain, while similar in origin to the flood plain, are older land surfaces of old abandoned flood plains and thus their soils exhibit more horizon development. This is the situation in Little Bighorn BNM.

Such soils as Havre and Haverson have few distinctive characteristics and no diagnostic subsurface horizons. These soils are mapped along the river corridors on the youngest geomorphic surfaces, generally on alluvial fans and flood plains. Because these two soils are on recent deposits of the river bottom, they have not existed long enough to develop well defined soil horizons. Most soils along the

Little Bighorn River reflect a minimal degree of pedogenesis. They lack horizonation because of the dynamic, changing landscape.

Such soils as Clapper on Greasy Grass Ridge that have horizons of calcium carbonate accumulation are on stable paleoterraces that have had time to develop very distinctive profile characteristics.

Topography and Relief

Topography refers to the shape of the landscape, and relief refers to differences in elevation. The overall landscape in a park, whether it consists of flat flood plains, rolling hills, or dissected terraces, is the result of erosion and depositional processes. These processes may have occurred in response to changes in climate, fluctuating sea levels, and/or tectonic activities. Cyclic periods of landscape stability and instability influence the types of soils that form on the landscape.

Slope shape and aspect of the overall landscape can affect the moisture and temperature of the soil. Steep slopes that face the sun are warmer. All steep soils may erode and lose their surface horizons as they form. Thus, these soils may be thinner or exhibit less profile development than more nearly level soils that receive deposits from areas upslope. Deeper, darker soils may be expected on the bottom land. Soil-forming factors continue to affect soils even on stable landscapes. Materials are deposited on the soil surface, and materials are blown or washed away from the surface. Additions, removals, and alterations are slow or rapid, depending on climate, landscape position, and biological activity.

Relief influences soil formation mainly through its effect on runoff and erosion. It also influences soil temperature, plant cover, depth to a water table, and the accumulation and removal of organic matter. Because it causes differences in external soil drainage, relief can differentiate soils that formed in the same kind of parent material. Water that runs off the more sloping soils can collect in depressions or drainageways. Midway soils formed in residuum and colluvium from calcareous shale on slopes of 15 to 40 percent on Greasy Grass Ridge. These soils are not very thick due to constant erosion. The nearly level Hesper soils on upland summits and side slopes are well drained. The nearly level Allentine soils on alluvial flats and terraces have accumulated salts in the lower part of the profile due to evapotranspiration and concentration of salts in shallow water tables.

Most of the soils of Little Bighorn BNM are affected by slope instability and high erosion rates, especially where the soil is left without vegetation. The geologic units underlying the slopes of the park contain a heterogeneous mix of shale, siltstone, and sandstone. Clay-rich units (such as shale and mudstone) may disaggregate when they become saturated with water and are prone to fail when exposed on a slope. Because of their high clay content and mineralogy, soils in these units tend to form cracks, which lead to piping, erosion, and slope failure. Piping may occur in soils that have subsurface horizons or layers that are more subject to entrainment in moving free water than the surface horizon or layer. The free water enters the soil in places where water ponds because of very gentle slopes and very slow infiltration. The water may flow into soil cracks. Cracks and rodent burrows are examples of macropores that may initiate the piping process. The soil material carried in the moving water moves downward within the soil and may move out of the soil completely if there is an outlet. The result is the formation of pipes which enlarge and coalesce (Soil Survey Division Staff, 1993). The portion of the pipe near the inlet may enlarge disproportionately to form a funnel-shaped feature sometimes referred to as a “jug.” This phenomenon is partly due to the presence of appreciable exchangeable sodium, as in Heldt and Allentine soils (see table 20).

Glenberg and Havre soils are on stream terraces at low elevations, in positions that are prone to frost action. Frost heave is a natural pedogenic process that mixes and

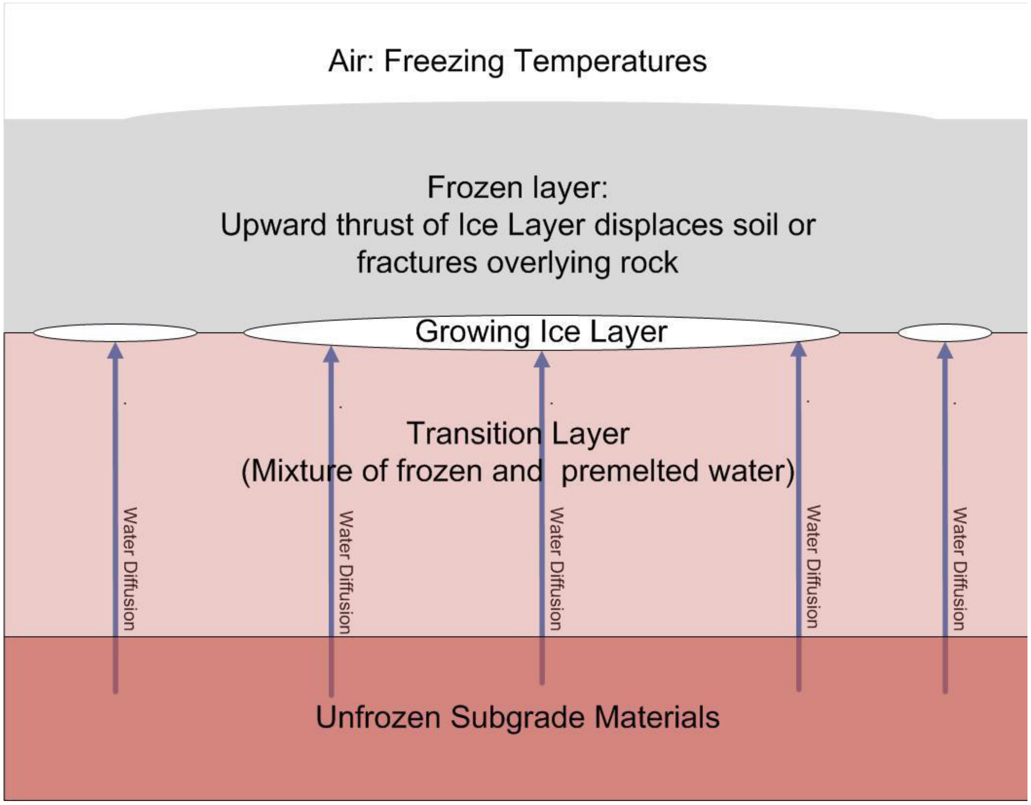

Figure 7.—Diagram illustrating ice lens formation in soils, which results in frost heave or frost action. (Image is from Williamborg [2009].)

breaks up the soil surface. Table 22 gives the potential for frost heave, or frost action, as low, moderate, or high. The soil properties of Glenberg and Havre soils, such as soil moisture and temperature, make them susceptible to frost action. These soils occur in landscape positions that are moist, and this moisture is available to form ice crystals. The landscape position of these soils (as in map unit 345971) receives cold air drainage that makes them more susceptible to frost and the natural pedogenic process of frost heave.

Frost heave results from ice forming beneath the surface of soil during atmospheric freezing conditions. The ice grows in the direction of heat loss, which is vertically toward the surface, starting at the freezing boundary in the soil. A water supply is needed to keep the ice crystals growing. The growing ice is restrained by overlying soil, which applies a load that limits its vertical growth and promotes the formation of a lens-shaped area of ice within the soil. Figure 7 describes ice lens formation.

Frost heave can result in road potholes and cracked pavements and foundations. Table 11 lists map units and soils that would have a limitation for roads and streets due to frost action. This limitation results in higher maintenance costs for park roads and parking lots.

Glenberg soils that are minor inclusions in map units on flood plains have a water table close enough to the surface and flood frequently enough to be classified as hydric soils (see table 4).

Relief and topography are also important in determining prime farmland map units. Because of landscape position, areas of very deep soils on flood plains with no root restrictions are often rated as prime farmland if irrigated (see table 3).

Classification of the Soils

Soils are named and classified on the basis of physical and chemical properties in their horizons (layers). Color, texture, structure, and other properties of the soil to a depth of 2 meters are used to key the soil into a classification system. This system helps people to use soil information and also provides a common language for scientists.

Soils and their horizons differ from one another, depending on how and when they formed. Soil scientists use the five soil-forming factors to help predict where different soils may occur. The degree and expression of the soil horizons reflect the extent of interaction of the soil-forming factors with one or more of the soil-forming processes (Simonson, 1959).

When mapping soils, a soil scientist looks for areas with similar soil-forming factors to find similar soils. The properties of the soils are described. Soils with the same kind of properties are given taxonomic names. Soils are classified, mapped, and interpreted on the basis of various kinds of soil horizons and their arrangement. The distribution of soil orders corresponds with the general patterns of the soil-forming factors within the park.

The system of soil classification used by the National Cooperative Soil Survey has six categories (Soil Survey Staff, 1999 and 2010). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. The categories are defined in the following paragraphs.

ORDER. Soil taxonomy at the highest hierarchical level identifies 12 soil orders. The names for the orders and taxonomic soil properties relate to Greek, Latin, or other root words that reveal something about the soil. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol.* An example is Entisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. Sixty-four suborders are recognized at the next level of classification. The last syllable in the name of a suborder indicates the order. An example is Orthents (*Orth* meaning common, plus *ent,* from Entisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; type of saturation; and base status. There are about 300 great groups. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Torriorthents (*Torri,* meaning hot and dry, plus *Orthent,* the suborder of the Torriorthents that is common or has minimal development).

SUBGROUP. There are more than 2,400 subgroups. Each great group has a typic subgroup. The typic subgroup is the central concept of the great group; it is not necessarily the most extensive. Other subgroups are intergrades or extragrades. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other taxonomic class. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Ustic* identifies the subgroup that has the distribution of seasonal precipitation of an ustic moisture regime (summer precipitation) but is in the dry Torriorthent great group. An example is Ustic Torriorthents.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the

properties for family placement are those of horizons below a traditional agronomic plow depth. Among the properties and characteristics considered are particle-size class, mineralogy class, cation-exchange activity class, soil temperature regime, soil depth, and reaction class. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is clayey, smectitic (calcareous), frigid, shallow Ustic Torriorthents.

SERIES. The soil series is the lowest category in the soil classification system. The series consists of soils within a family that have horizons similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. An example is the Midway series, which is classified as clayey, smectitic (calcareous), frigid, shallow Ustic Torriorthents.

Most parks are mapped to the series level. The names of soil series are selected by the soil scientists during the course of mapping. The series names are commonly geographic place names or are coined. Because of access limitations and soil variability, soils in some remote areas are classified at the great group or subgroup level.

Table 23 indicates the order, suborder, great group, subgroup, and family of the soil series in the park. Table 24 displays the classification as a key sorted by order.

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Glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvial fan. The fanlike deposit of a stream where it issues from a gorge upon a plain or of a tributary stream near or at its junction with its main stream.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Alpha,alpha-dipyridyl. A dye that when dissolved in 1N ammonium acetate is used to detect the presence of reduced iron (Fe II) in the soil. A positive reaction indicates a type of redoximorphic feature.

Aquic conditions. Current soil wetness characterized by saturation, reduction, and redoximorphic features.

Argillic horizon. A subsoil horizon characterized by an accumulation of illuvial clay.

Aspect. The direction in which a slope faces.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as:

Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Base saturation. The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, and K), expressed as a percentage of the total cation-exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Canopy. The leafy crown of trees or shrubs. (See Crown.)

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity but is more precise in meaning.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Climax plant community. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse textured soil. Sand or loamy sand.

Colluvium. Soil material or rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex, soil. A map unit of two or more kinds of soil or miscellaneous areas in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosion. Soil-induced electrochemical or chemical action that dissolves or weakens concrete or uncoated steel.

Crown. The upper part of a tree or shrub, including the living branches and their foliage.

Culmination of the mean annual increment (CMAI). The average annual increase per acre in the volume of a stand. Computed by dividing the total volume of the stand by its age. As the stand increases in age, the mean annual increment continues to increase until mortality begins to reduce the rate of increase. The point where the stand reaches its maximum annual rate of growth is called the culmination of the mean annual increment.

Depth, soil. Generally, the thickness of the soil over bedrock. Very deep soils are more than 60 inches deep over bedrock; deep soils, 40 to 60 inches; moderately deep, 20 to 40 inches; shallow, 10 to 20 inches; and very shallow, less than 10 inches.

Drainage class (natural). Refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Alterations of the water regime by human activities, either through drainage or irrigation, are not a consideration unless they have significantly changed the morphology of the soil. Seven classes of natural soil drainage are recognized—*excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained,* and *very poorly drained*. These classes are defined in the “Soil Survey Manual.”

Drainage, surface. Runoff, or surface flow of water, from an area.

Ecological site. An area where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. An ecological site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other ecological sites in kind and/or proportion of species or in total production.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building

up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of human or animal activities or of a catastrophe in nature, such as a fire, that exposes the surface.

Escarpment. A relatively continuous and steep slope or cliff breaking the general continuity of more gently sloping land surfaces and resulting from erosion or faulting. Synonym: scarp.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fill slope. A sloping surface consisting of excavated soil material from a road cut. It commonly is on the downhill side of the road.

Fine textured soil. Sandy clay, silty clay, or clay.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Fluvial. Of or pertaining to rivers; produced by river action, as a fluvial plain.

Forb. Any herbaceous plant not a grass or a sedge.

Forest cover. All trees and other woody plants (underbrush) covering the ground in a forest.

Forest type. A stand of trees similar in composition and development because of given physical and biological factors by which it may be differentiated from other stands.

Gravel. Rounded or angular fragments of rock as much as 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that has 15 to 35 percent, by volume, rounded or angular rock fragments, not prominently flattened, as much as 3 inches (7.6 centimeters) in diameter.

Ground water. Water filling all the unblocked pores of the material below the water table.

Hard bedrock. Bedrock that cannot be excavated except by blasting or by the use of special equipment that is not commonly used in construction.

Hill. A natural elevation of the land surface, rising as much as 1,000 feet above surrounding lowlands, commonly of limited summit area and having a well defined outline; hillsides generally have slopes of more than 15 percent. The distinction between a hill and a mountain is arbitrary and is dependent on local usage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the “Soil Survey Manual.” The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying soil material. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon, but it can be directly below an A or a B horizon.

Hydrologic soil groups. Refers to soils grouped according to their runoff potential. The soil properties that influence this potential are those that affect the minimum rate of water infiltration on a bare soil during periods after prolonged wetting when the soil is not frozen. These properties are depth to a seasonal high water table, the infiltration rate and permeability after prolonged wetting, and depth to a very slowly permeable layer. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake, in inches per hour, is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

K_{sat}. Saturated hydraulic conductivity. (See Permeability.)

Leaching. The removal of soluble material from soil or other material by percolating water.

LEP. See Linear extensibility percent.

Linear extensibility (LE). Refers to the change in length of an unconfined clod as moisture content is decreased from a moist to a dry state. Linear extensibility is used to determine the shrink-swell potential of soils. It is an expression of the volume change between the water content of the clod at $^{1}/_{3}$- or $^{1}/_{10}$-bar tension (33kPa or 10kPa tension) and oven dryness. Volume change is influenced by the amount and type of clay minerals in the soil. The volume change is the percent change for the whole soil. If it is expressed as a fraction, the resulting value is COLE, coefficient of linear extensibility.

Linear extensibility percent. Refers to the percent change in linear extensibility.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.
Low strength. The soil is not strong enough to support loads.
Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.
Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.
Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.
Moderately coarse textured soil. Coarse sandy loam, sandy loam, or fine sandy loam.
Moderately fine textured soil. Clay loam, sandy clay loam, or silty clay loam.
Neutral soil. A soil having a pH value of 6.6 to 7.3. (See Reaction, soil.)
Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.
Organic matter. Plant and animal residue in the soil in various stages of decomposition. The content of organic matter in the surface layer is described as follows:

Very low	less than 0.5 percent
Low	0.5 to 1.0 percent
Moderately low	1.0 to 2.0 percent
Moderate	2.0 to 4.0 percent
High	4.0 to 8.0 percent
Very high	more than 8.0 percent

Pan. A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, *hardpan, fragipan, claypan, plowpan,* and *traffic pan*.
Parent material. The unconsolidated organic and mineral material in which soil forms.
Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.
Pedon. The smallest volume that can be called “a soil.” A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.
Percolation. The movement of water through the soil.
Permeability. The quality of the soil that enables water or air to move downward through the profile. The rate at which a saturated soil transmits water is accepted as a measure of this quality. In soil physics, the rate is referred to as “saturated hydraulic conductivity,” which is defined in the “Soil Survey Manual.” In line with conventional usage in the engineering profession and with traditional usage in published soil surveys, this rate of flow continues to be expressed as “permeability.” Terms describing permeability, measured in inches per hour, are as follows:

Extremely slow	0.0 to 0.01 inch
Very slow	0.01 to 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management, such as slope, stoniness, and flooding.
pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)
Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.
Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Potential native plant community. See Climax plant community.

Potential rooting depth (effective rooting depth). Depth to which roots could penetrate if the content of moisture in the soil were adequate. The soil has no properties restricting the penetration of roots to this depth.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are:

Ultra acid	less than 3.5
Extremely acid	3.5 to 4.4
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Moderately acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Slightly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Redoximorphic concentrations. Nodules, concretions, soft masses, pore linings, and other features resulting from the accumulation of iron or manganese oxide. An indication of chemical reduction and oxidation resulting from saturation.

Redoximorphic depletions. Low-chroma zones from which iron and manganese oxide or a combination of iron and manganese oxide and clay has been removed. These zones are indications of the chemical reduction of iron resulting from saturation.

Redoximorphic features. Redoximorphic concentrations, redoximorphic depletions, reduced matrices, a positive reaction to alpha,alpha-dipyridyl, and other features indicating the chemical reduction and oxidation of iron and manganese compounds resulting from saturation.

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-sized particles.

Saprolite. Unconsolidated residual material underlying the soil and grading to hard bedrock below.

Saturation. Wetness characterized by zero or positive pressure of the soil water. Under conditions of saturation, the water will flow from the soil matrix into an unlined auger hole.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Series, soil. A group of soils that have profiles that are almost alike. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Sodic (alkali) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Sodicity. The degree to which a soil is affected by exchangeable sodium. Sodicity is expressed as a sodium adsorption ratio (SAR) of a saturation extract, or the ratio of Na^{+} to Ca^{++} + Mg^{++}. The degrees of sodicity and their respective ratios are:

Slight	less than 13:1
Moderate	13-30:1
Strong	more than 30:1

Sodium adsorption ratio (SAR). A measure of the amount of sodium (Na) relative to calcium (Ca) and magnesium (Mg) in the water extract from saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration.

Soft bedrock. Bedrock that can be excavated with trenching machines, backhoes, small rippers, and other equipment commonly used in construction.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the material below the solum. The living roots and plant and animal activities are largely confined to the solum.

Stone line. A concentration of coarse fragments in a soil. Generally, it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter if rounded or 15 to 24 inches (38 to 60 centimeters) in length if flat.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the “plow layer,” or the “Ap horizon.”

Surface soil. The A, E, AB, and EB horizons, considered collectively. It includes all subdivisions of these horizons.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet. A terrace in a field generally is built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying “coarse,” “fine,” or “very fine.”

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Upland. Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth’s surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Tables

Table 1.—Soil Legend

Map unit symbol and map unit name	Components in map unit	Percent of map unit
345897:		
Clapper-Midway complex, hilly	Clapper	55
	Midway	35
	Rock outcrop	10
345971:		
Haverson and Glenberg soils	Glenberg	45
	Haverson	45
	Havre	4
	Riverwash	4
	Somewhat poorly drained soils	2
345982:		
Haverson loam, 0 to 2 percent slopes	Haverson	90
	Glenberg	8
	Somewhat poorly drained soils	2
345992:		
Heldt silty clay loam, 4 to 8 percent slopes	Heldt	90
	Lohmiller	6
	Midway	4
345999:		
Hesper silty clay loam, 4 to 8 percent slopes	Hesper	90
	Keiser	10
346062:		
Midway silty clay loam, rolling	Midway	90
	Heldt	3
	McRae	3
	Lohmiller	2
	Nelson	1
	Thedalund	1
346063:		
Midway silty clay loam, hilly	Midway	80
	Heldt	8
	Lohmiller	7
	Rock outcrop	5

Table 1.—Soil Legend—Continued

Map unit symbol and map unit name	Components in map unit	Percent of map unit
346097:		
Pierre-Lismas clays, hilly	Lismas	60
	Pierre	30
	Harvey	5
	Rock outcrop	5
346102:		
Pierre clay, rolling	Pierre	85
	Lismas	8
	Kyle	7
346139:		
Shale outcrop	Rock outcrop, shale	80
	Eltsac	10
	Norbert	10
346140:		
Shale outcrop-Midway complex, steep	Rock outcrop, shale	45
	Midway	35
	Heldt	7
	Lismas	7
	Pierre	6
346194:		
Thurlow silty clay loam, 0 to 1 percent slopes	Thurlow	85
	Hydro	9
	Allentine	6
346196:		
Thurlow silty clay loam, 4 to 8 percent slopes	Thurlow	85
	Heldt	8
	Midway	7

Table 2.—Land Capability Classification

(Land capability classification is a system of grouping soils primarily on the basis of their capability to produce common cultivated crops and pasture plants without deteriorating over a long period of time. Only the soils suitable for cultivation are listed. N indicates nonirrigated areas; I indicates irrigated areas)

Map unit symbol and component name	Land capability N	Land capability I
345897:		
Clapper	6e	---
Midway	7e	---
345971:		
Glenberg	4w	4w
Haverson	3w	2w
345982:		
Haverson	3w	2w
345992:		
Heldt	3e	3e
345999:		
Hesper	3e	3e
346062:		
Midway	6e	---
346063:		
Midway	7e	---
346097:		
Lismas	7e	---
Pierre	6e	---
346102:		
Pierre	4e	---
346140:		
Midway	7e	---
346194:		
Thurlow	3c	2c
346196:		
Thurlow	3e	3e

Table 3.—Prime and Other Important Farmland

(Only the soils considered prime or important farmland are listed. Urban or built-up areas of the soils listed are not considered prime or important farmland. If a soil is prime or important farmland only under certain conditions, the conditions are indicated in the column "Farmland classification")

Map unit symbol	Map unit name	Farmland classification
345971	Haverson and Glenberg soils	Prime farmland if irrigated
345982	Haverson loam, 0 to 2 percent slopes	Prime farmland if irrigated
345992	Heldt silty clay loam, 4 to 8 percent slopes	Farmland of statewide importance
345999	Hesper silty clay loam, 4 to 8 percent slopes	Farmland of statewide importance
346194	Thurlow silty clay loam, 0 to 1 percent slopes	Prime farmland if irrigated
346196	Thurlow silty clay loam, 4 to 8 percent slopes	Farmland of statewide importance

Table 4.—Hydric Soils

(This report lists only those map unit components that are rated as hydric. Definitions of hydric criteria codes are included at the end of the report)

Map unit symbol and map unit name	Component	Percent of map unit	Landform	Hydric soils criteria			
				Hydric criteria code	Meets saturation criteria	Meets flooding criteria	Meets ponding criteria
345971:							
Haverson and Glenberg soils	Somewhat poorly drained soils	2	depressions	2A, 4	Yes	Yes	No
345982:							
Haverson loam, 0 to 2 percent slopes	Glenberg	8	flood plains and stream terraces	2B3, 4	Yes	Yes	No
	Somewhat poorly drained soils	2	flood plains	2A, 4	Yes	Yes	No

Explanation of hydric criteria codes

1. All Histels (except for Folistels), and Histosols (except for Folists), which are, by definition, saturated.
2. Soils in Aquic suborders, great groups, or subgroups, Albolls suborder, Historthels great group, Histoturbels great group, Pachic subgroups, or Cumulic subgroups that:
   A. are somewhat poorly drained and have a water table at the surface (0.0 feet) during the growing season, or
   B. are poorly drained or very poorly drained and have either:
      1.) a water table at the surface (0.0 feet) during the growing season if textures are coarse sand, sand, or fine sand in all layers within a depth of 20 inches, or
      2.) a water table at a depth of 0.5 foot or less during the growing season if permeability is equal to or greater than 6.0 in/hr in all layers within a depth of 20 inches, or
      3.) a water table at a depth of 1.0 foot or less during the growing season if permeability is less than 6.0 in/hr in any layer within a depth of 20 inches.
3. Soils that are frequently ponded for periods of long or very long duration during the growing season.
4. Soils that are frequently flooded for periods of long or very long duration during the growing season.

Table 5.—Ecological Sites

(Only soils and miscellaneous areas with correlated ecological sites are shown)

Map unit symbol soil name (%)	Ecological site name	Ecological site type	Ecological site ID
345897:			
Clapper (55%)	Silty (Si) RRU 58A-E 10-14″ p.z.	Rangeland	R058AE001MT
Midway (35%)	Clayey (Cy) RRU 58A-E 10-14″ p.z.	Rangeland	R058AE002MT
345971:			
Havre (4%)	Silty (Si) RRU 58A-E 10-14″ p.z.	Rangeland	R058AE001MT
345982:			
Haverson (90%)	Silty (Si) RRU 58A-E 10-14″ p.z.	Rangeland	R058AE001MT
Glenberg (8%)	Sandy (Sy) RRU 58A-E 10-14″ p.z.	Rangeland	R058AE003MT
345992:			
Heldt (90%)	Clayey (Cy) RRU 58A-E 10-14″ p.z.	Rangeland	R058AE002MT
Lohmiller (6%)	Clayey (Cy) RRU 58A-E 10-14″ p.z.	Rangeland	R058AE002MT
Midway (4%)	Clayey (Cy) RRU 58A-E 10-14″ p.z.	Rangeland	R058AE002MT
345999:			
Hesper (90%)	Clayey (Cy) RRU 58A-E 10-14″ p.z.	Rangeland	R058AE002MT
Keiser (10%)	Clayey (Cy) RRU 58A-E 10-14″ p.z.	Rangeland	R058AE002MT
346062:			
Midway (90%)	Clayey (Cy) RRU 58A-E 10-14″ p.z.	Rangeland	R058AE002MT
Heldt (3%)	Clayey (Cy) RRU 58A-E 10-14″ p.z.	Rangeland	R058AE002MT
McRae (3%)	Silty (Si) RRU 58A-E 10-14″ p.z.	Rangeland	R058AE001MT
Lohmiller (2%)	Clayey (Cy) RRU 58A-E 10-14″ p.z.	Rangeland	R058AE002MT
Nelson (1%)	Sandy (Sy) RRU 58A-E 10-14″ p.z.	Rangeland	R058AE003MT
Thedalund (1%)	Silty-Steep (SiStp) RRU 58A-E 10-14″ p.z.	Rangeland	R058AE004MT
346063:			
Midway (80%)	Shallow Clay (SwC) RRU 58A-E 10-14″ p.z.	Rangeland	R058AE199MT
Heldt (8%)	Clayey (Cy) RRU 58A-E 10-14″ p.z.	Rangeland	R058AE002MT
Lohmiller (7%)	Clayey (Cy) RRU 58A-E 10-14″ p.z.	Rangeland	R058AE002MT
346097:			
Lismas (60%)	Shallow Clay (SwC) RRU 58A-E 10-14″ p.z.	Rangeland	R058AE199MT
Pierre (30%)	Clayey (Cy) RRU 58A-E 10-14″ p.z.	Rangeland	R058AE002MT
Harvey (5%)	Silty (Si) RRU 58A-E 10-14″ p.z.	Rangeland	R058AE001MT
346102:			
Pierre (85%)	Clayey (Cy) RRU 58A-E 10-14″ p.z.	Rangeland	R058AE002MT
Lismas (8%)	Shallow Clay (SwC) RRU 58A-E 10-14″ p.z.	Rangeland	R058AE199MT
Kyle (7%)	Clayey (Cy) RRU 58A-E 10-14″ p.z.	Rangeland	R058AE002MT

Table 5.—Ecological Sites—Continued

Map unit symbol soil name (%)	Ecological site name	Ecological site type	Ecological site ID
346139:			
Eltsac (10%)	Thin Clayey (TCy) RRU 46-S 15-19″ p.z.	Rangeland	R046XS112MT
Norbert (10%)	Thin Clayey (TCy) RRU 46-S 15-19″ p.z.	Rangeland	R046XS112MT
346140:			
Midway (35%)	Clayey (Cy) RRU 58A-E 10-14″ p.z.	Rangeland	R058AE002MT
Heldt (7%)	Clayey (Cy) RRU 58A-E 10-14″ p.z.	Rangeland	R058AE002MT
Lismas (7%)	Shallow Clay (SwC) RRU 58A-E 10-14″ p.z.	Rangeland	R058AE199MT
Pierre (6%)	Clayey (Cy) RRU 58A-E 10-14″ p.z.	Rangeland	R058AE002MT
346194:			
Thurlow (85%)	Clayey (Cy) RRU 58A-E 10-14″ p.z.	Rangeland	R058AE002MT
Hydro (9%)	Silty (Si) RRU 58A-E 10-14″ p.z.	Rangeland	R058AE001MT
Allentine (6%)	Clayey (Cy) RRU 58A-E 10-14″ p.z.	Rangeland	R058AE002MT
346196:			
Thurlow (85%)	Clayey (Cy) RRU 58A-E 10-14″ p.z.	Rangeland	R058AE002MT
Heldt (8%)	Clayey (Cy) RRU 58A-E 10-14″ p.z.	Rangeland	R058AE002MT
Midway (7%)	Clayey (Cy) RRU 58A-E 10-14″ p.z.	Rangeland	R058AE002MT

Table 6.—Landscape, Parent Material, and Ecological Site

(Miscellaneous nonsoil components are not displayed in this report. Component percents may not add up to 100. MAP is the mean annual precipitation)

Map unit symbol and soil name	Percent of map unit	Slope	Elevation	MAP	Landscape	Landform	Parent material	Ecological site name and number
	Pct	Pct	Ft	In				
345897:								
Clapper	55	15-35	2500-3999	12-14	Plains	Paleoterrace	Gravelly alluvium	Silty (Si) RRU 58A-E 10-14″ p.z., R058AE001MT
Midway	35	15-40	---	10-14	Plains	Hill and stream terrace	Residuum weathered from shale	Clayey (Cy) RRU 58A-E 10-14″ p.z., R058AE002MT
345971:								
Haverson	45	0-2	1895-6000	12-14	Valleys	Flood plain and stream terrace	Alluvium	
Glenberg	45	0-2	1895-6000	12-14	Valleys	Flood plain and stream terrace	Alluvium	
345982:								
Haverson	90	0-2	1900-6001	12-14	Valleys	Flood plain and stream terrace	Alluvium	Silty (Si) RRU 58A-E 10-14″ p.z., R058AE001MT
345992:								
Heldt	90	4-8	2201-4301	12-14	Plains	Hill	Alluvium	Clayey (Cy) RRU 58A-E 10-14″ p.z., R058AE002MT
345999:								
Hesper	90	4-8	2700-3599	12-14	Plains	Paleoterrace	Alluvium and/or eolian deposits	Clayey (Cy) RRU 58A-E 10-14″ p.z., R058AE002MT
346062:								
Midway	90	8-15	---	10-14	Plains	Hill	Residuum weathered from shale	Clayey (Cy) RRU 58A-E 10-14″ p.z., R058AE002MT
346063:								
Midway	80	15-35	---	10-14	Plains	Hill	Residuum weathered from shale	Shallow Clay (SwC) RRU 58A-E 10-14″ p.z., R058AE199MT
346097:								
Lismas	60	25-45	---	12-14	Plains	Hill	Residuum weathered from shale	Shallow Clay (SwC) RRU 58A-E 10-14″ p.z., R058AE199MT
Pierre	30	15-20	2402-4501	12-14	Plains	Hill	Clayey residuum weathered from shale	Clayey (Cy) RRU 58A-E 10-14″ p.z., R058AE002MT

Table 6.—Landscape, Parent Material, and Ecological Site—Continued

Map unit symbol and soil name	Percent of map unit	Slope	Elevation	MAP	Landscape	Landform	Parent material	Ecological site name and number
	Pct	Pct	Ft	In				
346102:								
Pierre----------	85	8-15	2402-4501	12-14	Plains	Hill	Clayey residuum weathered from shale	Clayey (Cy) RRU 58A-E 10-14″ p.z., R058AE002MT
346140:								
Midway----------	35	25-70	---	10-14	Plains	Hill	Residuum weathered from shale	Clayey (Cy) RRU 58A-E 10-14″ p.z., R058AE002MT
346194:								
Thurlow---------	85	0-1	2201-3599	12-14	Valleys	Alluvial fan and stream terrace	Alluvium	Clayey (Cy) RRU 58A-E 10-14″ p.z., R058AE002MT
346196:								
Thurlow---------	85	4-8	2201-3599	12-14	Plains	Alluvial fan and hill	Alluvium	Clayey (Cy) RRU 58A-E 10-14″ p.z., R058AE002MT

Table 7.—Rangeland Productivity

(Only the soils that support rangeland vegetation suitable for grazing are rated)

Map unit symbol and soil name	Ecological site and symbol	Total dry-weight production		
		Favorable year	Normal year	Unfavorable year
		Lb/acre	Lb/acre	Lb/acre
345897:				
Clapper	Silty (Si) RRU 58A-E 10-14″ p.z. (R058AE001MT)	1,100	900	600
Midway	Clayey (Cy) RRU 58A-E 10-14″ p.z. (R058AE002MT)	1,200	1,000	700
345982:				
Haverson	Silty (Si) RRU 58A-E 10-14″ p.z. (R058AE001MT)	1,800	1,200	600
345992:				
Heldt	Clayey (Cy) RRU 58A-E 10-14″ p.z. (R058AE002MT)	1,800	1,200	600
345999:				
Hesper	Clayey (Cy) RRU 58A-E 10-14″ p.z. (R058AE002MT)	1,800	1,200	600
346062:				
Midway	Clayey (Cy) RRU 58A-E 10-14″ p.z. (R058AE002MT)	1,800	1,200	600
346063:				
Midway	Shallow Clay (SwC) RRU 58A-E 10-14″ p.z. (R058AE199MT)	1,300	1,000	650
346097:				
Lismas	Shallow Clay (SwC) RRU 58A-E 10-14″ p.z. (R058AE199MT)	1,100	800	600
Pierre	Clayey (Cy) RRU 58A-E 10-14″ p.z. (R058AE002MT)	1,800	1,300	900
346102:				
Pierre	Clayey (Cy) RRU 58A-E 10-14″ p.z. (R058AE002MT)	1,800	1,200	600
346140:				
Midway	Clayey (Cy) RRU 58A-E 10-14″ p.z. (R058AE002MT)	1,200	1,000	700
346194:				
Thurlow	Clayey (Cy) RRU 58A-E 10-14″ p.z. (R058AE002MT)	1,800	1,200	600
346196:				
Thurlow	Clayey (Cy) RRU 58A-E 10-14″ p.z. (R058AE002MT)	1,800	1,200	600

Table 8.—Land Management, Part I (Planting)

(Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table)

Map unit symbol and soil name	Pct. of map unit	Suitability for hand planting: Rating class and limiting features	Value	Suitability for mechanical planting: Rating class and limiting features	Value	Soil rutting hazard: Rating class and limiting features	Value
345897:							
Clapper	55	Well suited		Poorly suited		Slight	
				Slope	0.75	Strength	0.10
				Rock fragments	0.50		
Midway	35	Moderately suited		Unsuited		Severe	
		Stickiness; high plasticity index	0.50	Slope	1.00	Low strength	1.00
		Rock fragments	0.50	Rock fragments	0.75		
		Restrictive layer	0.50	Stickiness; high plasticity index	0.50		
345971:							
Glenberg	45	Well suited		Well suited		Moderate	
						Low strength	0.50
Haverson	45	Well suited		Well suited		Severe	
						Low strength	1.00
345982:							
Haverson	90	Well suited		Well suited		Severe	
						Low strength	1.00
345992:							
Heldt	90	Moderately suited		Moderately suited		Severe	
		Stickiness; high plasticity index	0.50	Slope	0.50	Low strength	1.00
				Stickiness; high plasticity index	0.50		
345999:							
Hesper	90	Moderately suited		Moderately suited		Severe	
		Stickiness; high plasticity index	0.50	Slope	0.50	Low strength	1.00
				Stickiness; high plasticity index	0.50		
346062:							
Midway	90	Moderately suited		Poorly suited		Severe	
		Stickiness; high plasticity index	0.50	Rock fragments	0.75	Low strength	1.00
		Rock fragments	0.50	Stickiness; high plasticity index	0.50		
		Restrictive layer	0.50	Slope	0.50		
346063:							
Midway	80	Moderately suited		Poorly suited		Severe	
		Stickiness; high plasticity index	0.50	Slope	0.75	Low strength	1.00
		Rock fragments	0.50	Rock fragments	0.75		
		Restrictive layer	0.50	Stickiness; high plasticity index	0.50		
346097:							
Lismas	60	Poorly suited		Unsuited		Severe	
		Stickiness; high plasticity index	0.75	Slope	1.00	Low strength	1.00
		Slope	0.50	Stickiness; high plasticity index	0.75		

Table 8.—Land Management, Part I (Planting)—Continued

Map unit symbol and soil name	Pct. of map unit	Suitability for hand planting: Rating class and limiting features	Value	Suitability for mechanical planting: Rating class and limiting features	Value	Soil rutting hazard: Rating class and limiting features	Value
346097:							
Pierre	30	Poorly suited		Poorly suited		Severe	
		Stickiness; high plasticity index	0.75	Slope	0.75	Low strength	1.00
				Stickiness; high plasticity index	0.75		
346102:							
Pierre	85	Poorly suited		Poorly suited		Severe	
		Stickiness; high plasticity index	0.75	Stickiness; high plasticity index	0.75	Low strength	1.00
				Slope	0.50		
346139:							
Rock outcrop, shale	80	Not rated		Not rated		Not rated	
346140:							
Rock outcrop, shale	45	Not rated		Not rated		Not rated	
Midway	35	Moderately suited		Unsuited		Severe	
		Stickiness; high plasticity index	0.50	Slope	1.00	Low strength	1.00
		Rock fragments	0.50	Rock fragments	0.75		
		Slope	0.50	Stickiness; high plasticity index	0.50		
		Restrictive layer	0.50				
346194:							
Thurlow	85	Moderately suited		Moderately suited		Severe	
		Stickiness; high plasticity index	0.50	Stickiness; high plasticity index	0.50	Low strength	1.00
346196:							
Thurlow	85	Moderately suited		Moderately suited		Severe	
		Stickiness; high plasticity index	0.50	Stickiness; high plasticity index	0.50	Low strength	1.00
				Slope	0.50		

Table 8.—Land Management, Part II (Hazard of Erosion and Suitability for Roads)

(Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table)

Map unit symbol and soil name	Pct. of map unit	Hazard of erosion: Rating class and limiting features	Value	Hazard of erosion on roads and trails: Rating class and limiting features	Value	Suitability for roads (natural surface): Rating class and limiting features	Value
345897:							
Clapper	55	Moderate		Severe		Poorly suited	
		Slope/erodibility	0.50	Slope/erodibility	0.95	Slope	1.00
Midway	35	Moderate		Severe		Poorly suited	
		Slope/erodibility	0.50	Slope/erodibility	0.95	Slope	1.00
						Low strength	0.50
345971:							
Glenberg	45	Slight		Slight		Moderately suited	
						Flooding	0.50
Haverson	45	Slight		Slight		Moderately suited	
						Low strength	0.50
						Flooding	0.50
345982:							
Haverson	90	Slight		Slight		Moderately suited	
						Low strength	0.50
						Flooding	0.50
345992:							
Heldt	90	Slight		Moderate		Moderately suited	
				Slope/erodibility	0.50	Low strength	0.50
						Slope	0.50
345999:							
Hesper	90	Slight		Moderate		Moderately suited	
				Slope/erodibility	0.50	Low strength	0.50
						Slope	0.50
346062:							
Midway	90	Slight		Severe		Moderately suited	
				Slope/erodibility	0.95	Slope	0.50
						Low strength	0.50
346063:							
Midway	80	Moderate		Severe		Poorly suited	
		Slope/erodibility	0.50	Slope/erodibility	0.95	Slope	1.00
						Low strength	0.50
346097:							
Lismas	60	Moderate		Severe		Poorly suited	
		Slope/erodibility	0.50	Slope/erodibility	0.95	Slope	1.00
						Stickiness; high plasticity index	0.50
						Low strength	0.50
Pierre	30	Moderate		Severe		Poorly suited	
		Slope/erodibility	0.50	Slope/erodibility	0.95	Slope	1.00
						Low strength	0.50

Table 8.—Land Management, Part II (Hazard of Erosion and Suitability for Roads)—Continued

Map unit symbol and soil name	Pct. of map unit	Hazard of erosion: Rating class and limiting features	Value	Hazard of erosion on roads and trails: Rating class and limiting features	Value	Suitability for roads (natural surface): Rating class and limiting features	Value
346102:							
Pierre	85	Slight		Moderate		Moderately suited	
				Slope/erodibility	0.50	Slope	0.50
						Low strength	0.50
346139:							
Rock outcrop, shale	80	Not rated		Not rated		Not rated	
346140:							
Rock outcrop, shale	45	Not rated		Not rated		Not rated	
Midway	35	Severe		Severe		Poorly suited	
		Slope/erodibility	0.75	Slope/erodibility	0.95	Slope	1.00
						Low strength	0.50
346194:							
Thurlow	85	Slight		Slight		Moderately suited	
						Low strength	0.50
346196:							
Thurlow	85	Slight		Moderate		Moderately suited	
				Slope/erodibility	0.50	Low strength	0.50
						Slope	0.50

Table 8.—Land Management, Part III (Site Preparation)

(Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table)

Map unit symbol and soil name	Pct. of map unit	Suitability for mechanical site preparation (deep): Rating class and limiting features	Value	Suitability for mechanical site preparation (surface): Rating class and limiting features	Value
345897:					
Clapper	55	Poorly suited		Poorly suited	
		Slope	0.50	Slope	0.50
Midway	35	Poorly suited		Poorly suited	
		Slope	0.50	Slope	0.50
				Rock fragments	0.50
345971:					
Glenberg	45	Well suited		Well suited	
Haverson	45	Well suited		Well suited	
345982:					
Haverson	90	Well suited		Well suited	
345992:					
Heldt	90	Well suited		Well suited	
345999:					
Hesper	90	Well suited		Well suited	
346062:					
Midway	90	Well suited		Poorly suited	
				Rock fragments	0.50
346063:					
Midway	80	Poorly suited		Poorly suited	
		Slope	0.50	Slope	0.50
				Rock fragments	0.50
346097:					
Lismas	60	Poorly suited		Poorly suited	
		Slope	0.50	Slope	0.50
				Stickiness; high plasticity index	0.50
Pierre	30	Poorly suited		Poorly suited	
		Slope	0.50	Slope	0.50
				Stickiness; high plasticity index	0.50
346102:					
Pierre	85	Well suited		Poorly suited	
				Stickiness; high plasticity index	0.50
346139:					
Rock outcrop, shale	80	Not rated		Not rated	

Table 8.—Land Management, Part III (Site Preparation)—Continued

Map unit symbol and soil name	Pct. of map unit	Suitability for mechanical site preparation (deep)		Suitability for mechanical site preparation (surface)	
		Rating class and limiting features	Value	Rating class and limiting features	Value
346140:					
Rock outcrop, shale	45	Not rated		Not rated	
Midway	35	Unsuited		Unsuited	
		Slope	1.00	Slope	1.00
				Rock fragments	0.50
346194:					
Thurlow	85	Well suited		Well suited	
346196:					
Thurlow	85	Well suited		Well suited	

Table 8.—Land Management, Part IV (Site Restoration)

(Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table)

Map unit symbol and soil name	Pct. of map unit	Potential for damage to soil by fire: Rating class and limiting features	Value	Potential for seedling mortality: Rating class and limiting features	Value
345897:					
Clapper	55	Low		Moderate Soil reaction	 0.50
Midway	35	Low		Low	
345971:					
Glenberg	45	Moderate Texture/rock fragments	 0.50	Moderate Salinity	 0.50
Haverson	45	Moderate Texture/rock fragments	 0.50	Moderate Soil reaction	 0.50
345982:					
Haverson	90	Moderate Texture/rock fragments	 0.50	Moderate Soil reaction	 0.50
345992:					
Heldt	90	Low		Low	
345999:					
Hesper	90	Low Texture/rock fragments	 0.10	Low	
346062:					
Midway	90	Low		Low	
346063:					
Midway	80	Low		Low	
346097:					
Lismas	60	High Texture/slope/ rock fragments	 1.00	Low	
Pierre	30	High Texture/surface layer thickness/rock fragments	 1.00	Moderate Soil reaction	 0.50
346102:					
Pierre	85	High Texture/surface layer thickness/rock fragments	 1.00	Moderate Soil reaction	 0.50

Table 8.—Land Management, Part IV (Site Restoration)—Continued

Map unit symbol and soil name	Pct. of map unit	Potential for damage to soil by fire		Potential for seedling mortality	
		Rating class and limiting features	Value	Rating class and limiting features	Value
346139:					
Rock outcrop, shale	80	Not rated		Not rated	
346140:					
Rock outcrop, shale	45	Not rated		Not rated	
Midway	35	High		Low	
		Texture/slope/ surface layer thickness/rock fragments	1.00		
346194:					
Thurlow	85	Low		Low	
346196:					
Thurlow	85	Low		Low	

Table 9.—Recreation, Part I (Camp and Picnic Areas)

(Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table)

Map unit symbol and soil name	Pct. of map unit	Camp areas: Rating class and limiting features	Camp areas: Value	Picnic areas: Rating class and limiting features	Picnic areas: Value
345897:					
Clapper	55	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Gravel	0.50	Gravel content	0.50
		Dusty	0.27	Dusty	0.27
Midway	35	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Depth to bedrock	1.00	Depth to bedrock	1.00
		Dusty	0.41	Dusty	0.41
		Slow water movement	0.39	Slow water movement	0.39
345971:					
Glenberg	45	Very limited		Not limited	
		Flooding	1.00		
Haverson	45	Very limited		Somewhat limited	
		Flooding	1.00	Dusty	0.09
		Dusty	0.09		
345982:					
Haverson	90	Very limited		Somewhat limited	
		Flooding	1.00	Dusty	0.09
		Dusty	0.09		
345992:					
Heldt	90	Somewhat limited		Somewhat limited	
		Slow water movement	0.94	Slow water movement	0.94
		Dusty	0.28	Dusty	0.28
345999:					
Hesper	90	Somewhat limited		Somewhat limited	
		Dusty	0.45	Dusty	0.45
346062:					
Midway	90	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to bedrock	1.00
		Slope	0.63	Slope	0.63
		Dusty	0.44	Dusty	0.44
		Slow water movement	0.39	Slow water movement	0.39
346063:					
Midway	80	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Depth to bedrock	1.00	Depth to bedrock	1.00
		Dusty	0.44	Dusty	0.44
		Slow water movement	0.39	Slow water movement	0.39

Table 9.—Recreation, Part I (Camp and Picnic Areas)—Continued

Map unit symbol and soil name	Pct. of map unit	Camp areas		Picnic areas	
		Rating class and limiting features	Value	Rating class and limiting features	Value
346097:					
Lismas	60	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Depth to bedrock	1.00	Depth to bedrock	1.00
		Too clayey	0.50	Too clayey	0.50
		Dusty	0.50	Dusty	0.50
		Slow water movement	0.39	Slow water movement	0.39
Pierre	30	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Too clayey	0.50	Too clayey	0.50
		Slow water movement	0.45	Slow water movement	0.45
		Dusty	0.28	Dusty	0.28
346102:					
Pierre	85	Somewhat limited		Somewhat limited	
		Slope	0.63	Slope	0.63
		Too clayey	0.50	Too clayey	0.50
		Slow water movement	0.45	Slow water movement	0.45
		Dusty	0.28	Dusty	0.28
346139:					
Rock outcrop, shale	80	Not rated		Not rated	
346140:					
Rock outcrop, shale	45	Not rated		Not rated	
Midway	35	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Depth to bedrock	1.00	Depth to bedrock	1.00
		Dusty	0.44	Dusty	0.44
		Slow water movement	0.39	Slow water movement	0.39
346194:					
Thurlow	85	Somewhat limited		Somewhat limited	
		Dusty	0.45	Dusty	0.45
346196:					
Thurlow	85	Somewhat limited		Somewhat limited	
		Dusty	0.45	Dusty	0.45

Table 9.—Recreation, Part II (Trail Management)

(Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table)

Map unit symbol and soil name	Pct. of map unit	Foot traffic and equestrian trails: Rating class and limiting features	Foot traffic and equestrian trails: Value	Mountain bike and off-road vehicle trails: Rating class and limiting features	Mountain bike and off-road vehicle trails: Value
345897:					
Clapper	55	Very limited		Somewhat limited	
		Slope	1.00	Dusty	0.50
		Dusty	0.50		
Midway	35	Very limited		Somewhat limited	
		Slope	1.00	Slope	0.08
345971:					
Glenberg	45	Not limited		Not limited	
Haverson	45	Somewhat limited		Somewhat limited	
		Dusty	0.50	Dusty	0.50
345982:					
Haverson	90	Somewhat limited		Somewhat limited	
		Dusty	0.50	Dusty	0.50
345992:					
Heldt	90	Not limited		Not limited	
345999:					
Hesper	90	Not limited		Not limited	
346062:					
Midway	90	Not limited		Not limited	
346063:					
Midway	80	Very limited		Not limited	
		Slope	1.00		
346097:					
Lismas	60	Very limited		Somewhat limited	
		Slope	1.00	Slope	0.78
		Too clayey	0.50	Too clayey	0.50
Pierre	30	Somewhat limited		Somewhat limited	
		Too clayey	0.50	Too clayey	0.50
		Slope	0.18		
346102:					
Pierre	85	Somewhat limited		Somewhat limited	
		Too clayey	0.50	Too clayey	0.50
346139:					
Rock outcrop, shale	80	Not rated		Not rated	
346140:					
Rock outcrop, shale	45	Not rated		Not rated	
Midway	35	Very limited		Very limited	
		Slope	1.00	Slope	1.00

Table 9.—Recreation, Part II (Trail Management)—Continued

Map unit symbol and soil name	Pct. of map unit	Foot traffic and equestrian trails: Rating class and limiting features	Foot traffic and equestrian trails: Value	Mountain bike and off-road vehicle trails: Rating class and limiting features	Mountain bike and off-road vehicle trails: Value
346194:					
Thurlow	85	Not limited		Not limited	
346196:					
Thurlow	85	Not limited		Not limited	

Table 10.—Dwellings and Small Commercial Buildings

(Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table)

Map unit symbol and soil name	Pct. of map unit	Dwellings without basements: Rating class and limiting features	Value	Dwellings with basements: Rating class and limiting features	Value	Small commercial buildings: Rating class and limiting features	Value
345897:							
Clapper	55	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
Midway	35	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Depth to soft bedrock	0.50	Shrink-swell	1.00	Depth to soft bedrock	1.00
				Depth to soft bedrock	1.00		
345971:							
Glenberg	45	Very limited		Very limited		Very limited	
		Flooding	1.00	Flooding	1.00	Flooding	1.00
Haverson	45	Very limited		Very limited		Very limited	
		Flooding	1.00	Flooding	1.00	Flooding	1.00
345982:							
Haverson	90	Very limited		Very limited		Very limited	
		Flooding	1.00	Flooding	1.00	Flooding	1.00
345992:							
Heldt	90	Very limited		Very limited		Very limited	
		Shrink-swell	1.00	Shrink-swell	1.00	Shrink-swell	1.00
						Slope	0.50
345999:							
Hesper	90	Somewhat limited		Somewhat limited		Somewhat limited	
		Shrink-swell	0.50	Shrink-swell	0.29	Slope	0.50
						Shrink-swell	0.50
346062:							
Midway	90	Somewhat limited		Very limited		Very limited	
		Slope	0.63	Shrink-swell	1.00	Slope	1.00
		Depth to soft bedrock	0.50	Depth to soft bedrock	1.00	Depth to soft bedrock	1.00
				Slope	0.63		
346063:							
Midway	80	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Depth to soft bedrock	0.50	Shrink-swell	1.00	Depth to soft bedrock	1.00
				Depth to soft bedrock	1.00		
346097:							
Lismas	60	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Depth to soft bedrock	0.50	Shrink-swell	1.00	Depth to soft bedrock	1.00
				Depth to soft bedrock	1.00		

Table 10.—Dwellings and Small Commercial Buildings—Continued

Map unit symbol and soil name	Pct. of map unit	Dwellings without basements: Rating class and limiting features	Value	Dwellings with basements: Rating class and limiting features	Value	Small commercial buildings: Rating class and limiting features	Value
346097:							
Pierre	30	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Shrink-swell	1.00	Shrink-swell	1.00	Shrink-swell	1.00
				Depth to soft bedrock	0.54		
346102:							
Pierre	85	Very limited		Very limited		Very limited	
		Shrink-swell	1.00	Shrink-swell	1.00	Slope	1.00
		Slope	0.63	Slope	0.63	Shrink-swell	1.00
				Depth to soft bedrock	0.54		
346139:							
Rock outcrop, shale	80	Not rated		Not rated		Not rated	
346140:							
Rock outcrop, shale	45	Not rated		Not rated		Not rated	
Midway	35	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Depth to soft bedrock	0.50	Shrink-swell	1.00	Depth to soft bedrock	1.00
				Depth to soft bedrock	1.00		
346194:							
Thurlow	85	Somewhat limited		Somewhat limited		Somewhat limited	
		Shrink-swell	0.50	Shrink-swell	0.50	Shrink-swell	0.50
346196:							
Thurlow	85	Somewhat limited		Somewhat limited		Somewhat limited	
		Shrink-swell	0.50	Shrink-swell	0.50	Slope	0.50
						Shrink-swell	0.50

Table 11.—Roads and Streets, Shallow Excavations, and Landscaping

(Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table)

Map unit symbol and soil name	Pct. of map unit	Local roads and streets: Rating class and limiting features	Value	Shallow excavations: Rating class and limiting features	Value	Landscaping: Rating class and limiting features	Value
345897:							
Clapper	55	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
				Unstable excavation walls	1.00	Gravel	0.50
						Droughty	0.10
Midway	35	Very limited		Very limited		Very limited	
		Slope	1.00	Depth to soft bedrock	1.00	Slope	1.00
		Depth to soft bedrock	1.00	Slope	1.00	Depth to bedrock	1.00
						Droughty	1.00
345971:							
Glenberg	45	Very limited		Very limited		Somewhat limited	
		Flooding	1.00	Unstable excavation walls	1.00	Flooding	0.60
		Frost action	0.50	Flooding	0.60		
Haverson	45	Very limited		Somewhat limited		Somewhat limited	
		Flooding	1.00	Flooding	0.60	Flooding	0.60
		Frost action	0.50	Unstable excavation walls	0.10		
345982:							
Haverson	90	Very limited		Somewhat limited		Somewhat limited	
		Flooding	1.00	Flooding	0.60	Flooding	0.60
		Frost action	0.50	Unstable excavation walls	0.10		
345992:							
Heldt	90	Very limited		Somewhat limited		Not limited	
		Shrink-swell	1.00	Unstable excavation walls	0.10		
		Low strength	1.00				
345999:							
Hesper	90	Very limited		Very limited		Not limited	
		Low strength	1.00	Unstable excavation walls	1.00		
		Shrink-swell	0.50				
346062:							
Midway	90	Somewhat limited		Very limited		Very limited	
		Depth to soft bedrock	1.00	Depth to soft bedrock	1.00	Depth to bedrock	1.00
						Droughty	1.00
		Slope	0.63	Slope	0.63	Slope	0.63
346063:							
Midway	80	Very limited		Very limited		Very limited	
		Slope	1.00	Depth to soft bedrock	1.00	Slope	1.00
		Depth to soft bedrock	1.00			Depth to bedrock	1.00
				Slope	1.00	Droughty	1.00
346097:							
Lismas	60	Very limited		Very limited		Very limited	
		Slope	1.00	Depth to soft bedrock	1.00	Slope	1.00
		Depth to soft bedrock	1.00			Too clayey	1.00
				Slope	1.00	Depth to bedrock	1.00
						Droughty	0.84

Table 11.—Roads and Streets, Shallow Excavations, and Landscaping—Continued

Map unit symbol and soil name	Pct. of map unit	Local roads and streets		Shallow excavations		Landscaping	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
346097:							
Pierre	30	Very limited		Very limited		Very limited	
		Slope	1.00	Slope	1.00	Slope	1.00
		Shrink-swell	1.00	Unstable excavation walls	1.00	Too clayey	1.00
		Low strength	1.00	Depth to soft bedrock	0.54	Depth to bedrock	0.54
			1.00	Too clayey	0.28		
346102:							
Pierre	85	Very limited		Very limited		Very limited	
		Shrink-swell	1.00	Unstable excavation walls	1.00	Too clayey	1.00
		Low strength	1.00	Slope	0.63	Slope	0.63
		Slope	0.63	Depth to soft bedrock	0.54	Depth to bedrock	0.54
				Too clayey	0.28		
346139:							
Rock outcrop, shale	80	Not rated		Not rated		Not rated	
346140:							
Rock outcrop, shale	45	Not rated		Not rated		Not rated	
Midway	35	Very limited		Very limited		Very limited	
		Slope	1.00	Depth to soft bedrock	1.00	Slope	1.00
		Depth to soft bedrock	1.00	Slope	1.00	Depth to bedrock	1.00
						Droughty	1.00
346194:							
Thurlow	85	Very limited		Somewhat limited		Not limited	
		Low strength	1.00	Unstable excavation walls	0.10		
		Shrink-swell	0.50				
346196:							
Thurlow	85	Very limited		Somewhat limited		Not limited	
		Low strength	1.00	Unstable excavation walls	0.10		
		Shrink-swell	0.50				

Table 12.—Sewage Disposal

(Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table)

Map unit symbol and soil name	Pct. of map unit	Septic tank absorption fields: Rating class and limiting features	Value	Sewage lagoons: Rating class and limiting features	Value
345897:					
Clapper	55	Very limited		Very limited	
		Slope	1.00	Slope	1.00
		Slow water movement	0.50	Seepage	0.50
Midway	35	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to soft bedrock	1.00
		Slope	1.00	Slope	1.00
345971:					
Glenberg	45	Very limited		Very limited	
		Flooding	1.00	Flooding	1.00
				Seepage	1.00
Haverson	45	Very limited		Very limited	
		Flooding	1.00	Flooding	1.00
		Slow water movement	0.50	Seepage	0.50
345982:					
Haverson	90	Very limited		Very limited	
		Flooding	1.00	Flooding	1.00
		Slow water movement	0.50	Seepage	0.50
345992:					
Heldt	90	Very limited		Somewhat limited	
		Slow water movement	1.00	Slope	0.92
345999:					
Hesper	90	Very limited		Somewhat limited	
		Slow water movement	1.00	Slope	0.92
				Seepage	0.50
346062:					
Midway	90	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to soft bedrock	1.00
		Slope	0.63	Slope	1.00
346063:					
Midway	80	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to soft bedrock	1.00
		Slope	1.00	Slope	1.00
346097:					
Lismas	60	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to soft bedrock	1.00
		Slope	1.00	Slope	1.00

Table 12.—Sewage Disposal—Continued

Map unit symbol and soil name	Pct. of map unit	Septic tank absorption fields: Rating class and limiting features	Septic tank absorption fields: Value	Sewage lagoons: Rating class and limiting features	Sewage lagoons: Value
346097:					
Pierre	30	Very limited		Very limited	
		Slow water movement	1.00	Depth to soft bedrock	1.00
		Slope	1.00	Slope	1.00
		Depth to bedrock	1.00		
346102:					
Pierre	85	Very limited		Very limited	
		Slow water movement	1.00	Depth to soft bedrock	1.00
		Depth to bedrock	1.00	Slope	1.00
		Slope	0.63		
346139:					
Rock outcrop, shale	80	Not rated		Not rated	
346140:					
Rock outcrop, shale	45	Not rated		Not rated	
Midway	35	Very limited		Very limited	
		Depth to bedrock	1.00	Depth to soft bedrock	1.00
		Slope	1.00	Slope	1.00
346194:					
Thurlow	85	Very limited		Not limited	
		Slow water movement	1.00		
346196:					
Thurlow	85	Very limited		Somewhat limited	
		Slow water movement	1.00	Slope	0.92

Table 13.—Source of Gravel and Sand

(Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The ratings given for the thickest layer are for the thickest layer above and excluding the bottom layer. The numbers in the value columns range from 0.00 to 0.99. The greater the value, the greater the likelihood that the bottom layer or thickest layer of the soil is a source of sand or gravel. See text for further explanation of ratings in this table)

Map unit symbol and soil name	Pct. of map unit	Gravel source: Rating class and limiting features	Gravel source: Value	Sand source: Rating class and limiting features	Sand source: Value
345897:					
Clapper	55	Fair		Poor	
		Thickest layer	0.00	Bottom layer	0.00
		Bottom layer	0.25	Thickest layer	0.00
Midway	35	Poor		Not rated	
		Bottom layer	0.00		
		Thickest layer	0.00		
345971:					
Glenberg	45	Poor		Fair	
		Bottom layer	0.00	Thickest layer	0.00
		Thickest layer	0.00	Bottom layer	0.07
Haverson	45	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
345982:					
Haverson	90	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
345992:					
Heldt	90	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
345999:					
Hesper	90	Poor		Fair	
		Thickest layer	0.00	Thickest layer	0.00
		Bottom layer	0.00	Bottom layer	0.34
346062:					
Midway	90	Poor		Not rated	
		Bottom layer	0.00		
		Thickest layer	0.00		
346063:					
Midway	80	Poor		Not rated	
		Bottom layer	0.00		
		Thickest layer	0.00		
346097:					
Lismas	60	Poor		Not rated	
		Bottom layer	0.00		
		Thickest layer	0.00		
Pierre	30	Poor		Not rated	
		Bottom layer	0.00		
		Thickest layer	0.00		

Table 13.—Source of Gravel and Sand—Continued

Map unit symbol and soil name	Pct. of map unit	Gravel source: Rating class and limiting features	Gravel source: Value	Sand source: Rating class and limiting features	Sand source: Value
346102:					
Pierre	85	Poor		Not rated	
		Bottom layer	0.00		
		Thickest layer	0.00		
346139:					
Rock outcrop, shale	80	Not rated		Not rated	
346140:					
Rock outcrop, shale	45	Not rated		Not rated	
Midway	35	Poor		Not rated	
		Bottom layer	0.00		
		Thickest layer	0.00		
346194:					
Thurlow	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00
346196:					
Thurlow	85	Poor		Poor	
		Bottom layer	0.00	Bottom layer	0.00
		Thickest layer	0.00	Thickest layer	0.00

Table 14.—Source of Reclamation Material, Roadfill, and Topsoil

(Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.00 to 0.99. The smaller the value, the greater the limitation. See text for further explanation of ratings in this table)

Map unit symbol and soil name	Pct. of map unit	Source of reclamation material: Rating class and limiting features	Value	Roadfill source: Rating class and limiting features	Value	Topsoil source: Rating class and limiting features	Value
345897:							
Clapper	55	Fair		Poor		Poor	
		Low content of organic matter	0.13	Slope	0.00	Rock fragments	0.00
		Carbonate content	0.46			Slope	0.00
		Droughty	0.70			Hard to reclaim (rock fragments)	0.00
Midway	35	Not rated		Poor		Not rated	
				Depth to bedrock	0.00		
				Slope	0.00		
				Shrink-swell	0.13		
345971:							
Glenberg	45	Fair		Good		Fair	
		Too sandy	0.18			Too sandy	0.18
		Low content of organic matter	0.88			Salinity	0.88
						Rock fragments	0.97
Haverson	45	Fair		Good		Good	
		Low content of organic matter	0.88				
345982:							
Haverson	90	Fair		Good		Good	
		Low content of organic matter	0.88				
345992:							
Heldt	90	Poor		Poor		Poor	
		Too clayey	0.00	Low strength	0.00	Too clayey	0.00
		Sodium content	0.61	Shrink-swell	0.13	Sodium content	0.78
		Low content of organic matter	0.88				
345999:							
Hesper	90	Fair		Poor		Fair	
		Too clayey	0.76	Low strength	0.00	Hard to reclaim (rock fragments)	0.32
		Low content of organic matter	0.88	Shrink-swell	0.93	Too clayey	0.54
		Water erosion	0.99				
346062:							
Midway	90	Not rated ???		Poor		Not rated	
				Depth to bedrock	0.00		
				Shrink-swell	0.13		
346063:							
Midway	80	Not rated ???		Poor		Not rated	
				Depth to bedrock	0.00		
				Slope	0.00		
				Shrink-swell	0.13		

Table 14.—Source of Reclamation Material, Roadfill, and Topsoil—Continued

Map unit symbol and soil name	Pct. of map unit	Source of reclamation material: Rating class and limiting features	Value	Roadfill source: Rating class and limiting features	Value	Topsoil source: Rating class and limiting features	Value
346097:							
Lismas	60	Not rated ???		Poor		Not rated	
				Depth to bedrock	0.00		
				Slope	0.00		
				Shrink-swell	0.13		
Pierre	30	Poor		Poor		Poor	
		Low content of organic matter	0.00	Depth to bedrock	0.00	Slope	0.00
		Too clayey	0.00	Shrink-swell	0.13	Too clayey	0.00
		Depth to bedrock	0.46	Slope	0.82	Depth to bedrock	0.46
346102:							
Pierre	85	Poor		Poor		Poor	
		Low content of organic matter	0.00	Depth to bedrock	0.00	Too clayey	0.00
		Too clayey	0.00	Shrink-swell	0.13	Slope	0.37
		Depth to bedrock	0.46			Depth to bedrock	0.46
346139:							
Rock outcrop, shale	80	Not rated		Not rated		Not rated	
346140:							
Rock outcrop, shale	45	Not rated		Not rated		Not rated	
Midway	35	Not rated ???		Poor		Not rated	
				Depth to bedrock	0.00		
				Slope	0.00		
				Shrink-swell	0.13		
346194:							
Thurlow	85	Fair		Poor		Fair	
		Low content of organic matter	0.88	Low strength	0.00	Too clayey	0.70
		Water erosion	0.90	Shrink-swell	0.87		
		Too clayey	0.98				
346196:							
Thurlow	85	Fair		Poor		Fair	
		Low content of organic matter	0.88	Low strength	0.00	Too clayey	0.70
		Water erosion	0.90	Shrink-swell	0.87		
		Too clayey	0.98				

Table 15.—Ponds and Embankments

(Onsite investigation may be needed to validate the interpretations in this table and to confirm the identity of the soil on a given site. The numbers in the value columns range from 0.01 to 1.00. The larger the value, the greater the limitation. See text for further explanation of ratings in this table)

Map unit symbol and soil name	Pct. of map unit	Pond reservoir areas		Embankments, dikes, and levees		Aquifer-fed excavated ponds	
		Rating class and limiting features	Value	Rating class and limiting features	Value	Rating class and limiting features	Value
345897:							
Clapper	55	Very limited		Somewhat limited		Very limited	
		Slope	1.00	Seepage	0.47	Depth to water	1.00
		Seepage	0.70				
Midway	35	Very limited		Not limited		Very limited	
		Slope	1.00			Depth to water	1.00
		Depth to bedrock	0.81				
345971:							
Glenberg	45	Very limited		Not limited		Very limited	
		Seepage	1.00			Depth to water	1.00
Haverson	45	Somewhat limited		Very limited		Very limited	
		Seepage	0.70	Piping	1.00	Depth to water	1.00
345982:							
Haverson	90	Somewhat limited		Very limited		Very limited	
		Seepage	0.70	Piping	1.00	Depth to water	1.00
345992:							
Heldt	90	Somewhat limited		Somewhat limited		Very limited	
		Slope	0.68	Piping	0.40	Depth to water	1.00
345999:							
Hesper	90	Somewhat limited		Somewhat limited		Very limited	
		Seepage	0.70	Piping	0.67	Depth to water	1.00
		Slope	0.68				
346062:							
Midway	90	Very limited		Not limited		Very limited	
		Slope	1.00			Depth to water	1.00
		Depth to bedrock	0.81				
346063:							
Midway	80	Very limited		Not limited		Very limited	
		Slope	1.00			Depth to water	1.00
		Depth to bedrock	0.81				
346097:							
Lismas	60	Very limited		Somewhat limited		Very limited	
		Slope	1.00	Hard to pack	0.88	Depth to water	1.00
		Depth to bedrock	0.54				
Pierre	30	Very limited		Somewhat limited		Very limited	
		Slope	1.00	Hard to pack	0.68	Depth to water	1.00
		Depth to bedrock	0.14				
346102:							
Pierre	85	Very limited		Somewhat limited		Very limited	
		Slope	1.00	Hard to pack	0.68	Depth to water	1.00
		Depth to bedrock	0.14				

Table 15.—Ponds and Embankments—Continued

Map unit symbol and soil name	Pct. of map unit	Pond reservoir areas: Rating class and limiting features	Pond reservoir areas: Value	Embankments, dikes, and levees: Rating class and limiting features	Embankments, dikes, and levees: Value	Aquifer-fed excavated ponds: Rating class and limiting features	Aquifer-fed excavated ponds: Value
346139:							
Rock outcrop, shale	80	Not rated		Not rated		Not rated	
346140:							
Rock outcrop, shale	45	Not rated		Not rated		Not rated	
Midway	35	Very limited		Not limited		Very limited	
		Slope	1.00			Depth to water	1.00
		Depth to bedrock	0.81				
346194:							
Thurlow	85	Somewhat limited		Somewhat limited		Very limited	
		Seepage	0.05	Piping	0.20	Depth to water	1.00
346196:							
Thurlow	85	Somewhat limited		Somewhat limited		Very limited	
		Slope	0.68	Piping	0.20	Depth to water	1.00
		Seepage	0.05				

Table 16.—Engineering Properties

(Absence of an entry indicates that data were not estimated)

Map unit symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	>10 in	3-10 in	4	10	40	200		
	In				Pct	Pct					Pct	
345897:												
Clapper----------	0-4	Gravelly loam	SC-SM, GC-GM	A-4, A-2	0	0	55-80	50-75	45-70	30-50	25-30	5-10
	4-16	Gravelly loam, gravelly clay loam	GC, GC-GM, CL, CL-ML	A-6, A-4, A-2	0	0	55-80	50-75	45-70	30-60	25-40	5-20
	16-60	Very gravelly loam, very cobbly loam, extremely gravelly loam	GC-GM	A-2	0	5-45	25-55	20-55	15-50	10-35	25-30	5-10
Midway-----------	0-2	Clay loam	CL	A-7, A-6	0	0	100	100	90-100	80-90	30-45	10-20
	2-11	Silty clay loam, clay loam, clay	CL, CH	A-7	0	0	100	100	90-100	70-95	40-60	15-35
	11-60	Bedrock	---	---	---	---	---	---	---	---	---	---
345971:												
Glenberg---------	0-5	Fine sandy loam	CL-ML, ML, SC-SM, SM	A-4, A-2	0	0	100	100	65-85	30-55	20-30	NP-10
	5-60	Stratified loamy fine sand to silt loam	SM, SC-SM	A-4, A-2	0	0	95-100	75-100	60-80	25-50	15-25	NP-10
Haverson---------	0-12	Loam	ML, CL-ML	A-4	0	0	100	100	80-95	60-75	20-30	NP-10
	12-60	Stratified loam to fine sandy loam	CL-ML, CL	A-4, A-6	0	0	100	100	80-95	50-70	20-35	5-15
345982:												
Haverson---------	0-12	Loam	ML, CL-ML	A-4	0	0	100	100	80-95	60-75	20-30	NP-10
	12-60	Stratified loam to fine sandy loam	CL-ML, CL	A-4, A-6	0	0	100	100	80-95	50-70	20-35	5-15
345992:												
Heldt------------	0-4	Silty clay loam	CL	A-7, A-6	0	0	95-100	90-100	85-100	80-95	30-45	10-20
	4-10	Silty clay loam, silty clay, clay	CL	A-7, A-6	0	0	95-100	90-100	85-100	75-95	35-50	15-25
	10-22	Silty clay loam, silty clay, clay	CL	A-7, A-6	0	0	95-100	90-100	85-100	75-95	35-50	15-25
	22-60	Silty clay loam, silty clay, clay	CL	A-7, A-6	0	0	95-100	90-100	85-100	75-95	35-50	15-25

Table 16.—Engineering Properties—Continued

Map unit symbol and soil name	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments: >10 in	Fragments: 3-10 in	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct	Pct					Pct	
345999:												
Hesper	0-6	Silty clay loam	CL	A-6	0	0	100	100	85-100	75-100	30-40	10-20
	6-14	Silty clay loam, silty clay	CL	A-7, A-6	0	0	100	100	95-100	90-100	35-50	15-30
	14-22	Silty clay loam, silty clay	CL	A-7, A-6	0	0	100	100	95-100	90-100	30-45	10-25
	22-49	Silty clay loam	CL	A-6	0	0	100	100	95-100	90-100	30-40	10-20
	49-60	Very fine sandy loam, very gravelly sand, gravelly sandy loam	SM, SP-SM, GM, GP-GM	A-3, A-2, A-1	0	0	40-90	35-85	20-75	5-35	20-30	NP-5
346062:												
Midway	0-2	Silty clay loam	CL	A-7, A-6	0	0	100	100	90-100	80-90	30-45	10-20
	2-11	Silty clay loam, clay loam, clay	CL, CH	A-7	0	0	100	100	90-100	70-95	40-60	15-35
	11-60	Bedrock	---	---	---	---	---	---	---	---	---	---
346063:												
Midway	0-2	Silty clay loam	CL	A-7, A-6	0	0	100	100	90-100	80-90	30-45	10-20
	2-11	Silty clay loam, clay loam, clay	CL, CH	A-7	0	0	100	100	90-100	70-95	40-60	15-35
	11-60	Bedrock	---	---	---	---	---	---	---	---	---	---
346097:												
Lismas	0-6	Clay	CH	A-7	0	0	100	100	90-100	80-95	55-65	30-40
	6-18	Clay	CH	A-7	0	0	100	100	90-100	80-95	55-65	30-40
	18-60	Bedrock	---	---	---	---	---	---	---	---	---	---
Pierre	0-3	Clay	CL, CH	A-7	0	0	95-100	90-100	80-100	75-95	40-60	20-35
	3-29	Silty clay, clay, silty clay loam	CL, CH	A-7, A-6	0	0	80-100	75-100	65-100	60-95	35-65	20-45
	29-60	Bedrock	---	---	---	---	---	---	---	---	---	---
346102:												
Pierre	0-3	Clay	CL, CH	A-7	0	0	95-100	90-100	80-100	75-95	40-60	20-35
	3-29	Silty clay, clay, silty clay loam	CL, CH	A-7, A-6	0	0	80-100	75-100	65-100	60-95	35-65	20-45
	29-60	Bedrock	---	---	---	---	---	---	---	---	---	---
346140:												
Midway	0-2	Silty clay loam	CL	A-7, A-6	0	0	100	100	90-100	80-90	30-45	10-20
	2-11	Silty clay loam, clay loam, clay	CL, CH	A-7	0	0	100	100	90-100	70-95	40-60	15-35
	11-60	Bedrock	---	---	---	---	---	---	---	---	---	---

Table 16.—Engineering Properties—Continued

Map unit symbol and soil name	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments >10 in	Fragments 3-10 in	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct	Pct					Pct	
346194:												
Thurlow---------	0-2	Silty clay loam	CL	A-6	0	0	100	100	95-100	80-100	30-40	10-20
	2-13	Clay loam, silty clay loam, silty clay	CL	A-7	0	0	100	100	90-100	70-90	40-50	20-30
	13-61	Clay loam, silty clay loam	CL	A-6	0	0	100	100	90-100	70-90	30-40	10-20
346196:												
Thurlow---------	0-2	Silty clay loam	CL	A-6	0	0	100	100	95-100	80-100	30-40	10-20
	2-13	Clay loam, silty clay loam, silty clay	CL	A-7	0	0	100	100	90-100	70-90	40-50	20-30
	13-61	Clay loam, silty clay loam	CL	A-6	0	0	100	100	90-100	70-90	30-40	10-20

Table 17.—Physical Soil Properties

(Sand, silt, and clay values are shown either as a range or as a representative value. Absence of an entry indicates that data were not estimated. Soil properties are measured or inferred from direct observations in the field or laboratory)

Map unit symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Permeability (Ksat)	Available water capacity	Shrink-swell potential	Organic matter
	In	Pct	Pct	Pct	g/cc	In/hr	In/in	Pct	Pct
345897:									
Clapper----------	0-4	42	38	15-25	1.30-1.50	0.6-2.0	0.13-0.15	0.0-2.9	1.0-2.0
	4-16	38	36	15-35	1.35-1.55	0.6-2.0	0.12-0.14	3.0-5.9	0.5-1.0
	16-60	42	38	15-25	1.40-1.65	0.6-2.0	0.05-0.06	0.0-2.9	0.0-0.5
Midway----------	0-2	34	32	27-40	1.10-1.30	0.2-0.6	0.17-0.20	3.0-5.9	0.5-1.0
	2-11	28	29	35-50	1.20-1.40	0.1-0.2	0.15-0.18	6.0-8.9	0.0-0.5
	11-60	---	---	---	---	---	---	---	---
345971:									
Glenberg--------	0-5	68	22	5-15	1.40-1.60	2.0-5.9	0.10-0.13	0.0-2.9	0.5-2.0
	5-60	84	5	5-18	1.35-1.60	2.0-5.9	0.10-0.13	0.0-2.9	0.5-1.0
Haverson--------	0-12	44	40	10-22	1.15-1.35	0.6-2.0	0.16-0.20	0.0-2.9	0.5-2.0
	12-60	39	37	18-30	1.30-1.55	0.6-2.0	0.14-0.18	0.0-2.9	0.5-1.0
345982:									
Haverson--------	0-12	44	40	10-22	1.15-1.35	0.6-2.0	0.16-0.20	0.0-2.9	0.5-2.0
	12-60	39	37	18-30	1.30-1.55	0.6-2.0	0.14-0.18	0.0-2.9	0.5-1.0
345992:									
Heldt-----------	0-4	18	49	27-40	1.20-1.40	0.2-0.6	0.16-0.20	3.0-5.9	1.0-2.0
	4-10	8	52	35-45	1.30-1.50	0.1-0.2	0.14-0.18	6.0-8.9	0.5-1.0
	10-22	8	52	35-45	1.30-1.55	0.1-0.2	0.14-0.18	6.0-8.9	0.5-1.0
	22-60	8	52	35-45	1.30-1.55	0.1-0.2	0.14-0.18	6.0-8.9	0.5-1.0
345999:									
Hesper----------	0-6	17	53	25-35	1.10-1.30	0.2-0.6	0.18-0.20	3.0-5.9	2.0-4.0
	6-14	8	50	35-50	1.20-1.40	0.2-0.6	0.16-0.18	6.0-8.9	1.0-2.0
	14-22	18	44	30-45	1.25-1.45	0.2-0.6	0.16-0.18	3.0-5.9	0.5-1.0
	22-49	18	49	27-40	1.30-1.50	0.2-0.6	0.18-0.20	3.0-5.9	0.5-1.0
	49-60	91	2	5-10	1.50-1.70	0.6-2.0	0.10-0.12	0.0-2.9	0.0-0.5
346062:									
Midway----------	0-2	18	49	27-40	1.10-1.30	0.2-0.6	0.17-0.20	3.0-5.9	0.5-1.0
	2-11	28	29	35-50	1.20-1.40	0.1-0.2	0.15-0.18	6.0-8.9	0.0-0.5
	11-60	---	---	---	---	---	---	---	---
346063:									
Midway----------	0-2	18	49	27-40	1.10-1.30	0.2-0.6	0.17-0.20	3.0-5.9	0.5-1.0
	2-11	28	29	35-50	1.20-1.40	0.1-0.2	0.15-0.18	6.0-8.9	0.0-0.5
	11-60	---	---	---	---	---	---	---	---

Table 17.—Physical Soil Properties--Cntinued

Map unit symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Permeability (Ksat)	Available water capacity	Shrink-swell potential	Organic matter
	In	Pct	Pct	Pct	g/cc	In/hr	In/in	Pct	Pct
346097:									
Lismas----------	0-6	17	28	50-60	1.20-1.40	0.1-0.2	0.12-0.15	6.0-8.9	0.5-1.0
	6-18	17	28	50-60	1.30-1.50	0.1-0.2	0.12-0.15	6.0-8.9	0.0-0.5
	18-60	---	---	---	---	---	---	---	---
Pierre----------	0-3	23	29	40-55	1.20-1.40	0.2-0.6	0.14-0.18	6.0-8.9	1.0-2.0
	3-29	6	47	35-60	1.30-1.55	0.0-0.1	0.14-0.16	6.0-8.9	0.5-1.0
	29-60	---	---	---	---	---	---	---	---
346102:									
Pierre----------	0-3	23	29	40-55	1.20-1.40	0.2-0.6	0.14-0.18	6.0-8.9	1.0-2.0
	3-29	6	47	35-60	1.30-1.55	0.0-0.1	0.14-0.16	6.0-8.9	0.5-1.0
	29-60	---	---	---	---	---	---	---	---
346140:									
Midway----------	0-2	18	49	27-40	1.10-1.30	0.2-0.6	0.17-0.20	3.0-5.9	0.5-1.0
	2-11	28	29	35-50	1.20-1.40	0.1-0.2	0.15-0.18	6.0-8.9	0.0-0.5
	11-60	---	---	---	---	---	---	---	---
346194:									
Thurlow---------	0-2	18	51	27-35	1.15-1.35	0.2-0.6	0.18-0.20	3.0-5.9	3.0-5.0
	2-13	8	52	35-45	1.25-1.45	0.2-0.6	0.14-0.16	3.0-5.9	1.0-2.0
	13-61	18	51	27-35	1.30-1.50	0.2-0.6	0.14-0.16	3.0-5.9	0.5-1.0
346196:									
Thurlow---------	0-2	18	51	27-35	1.15-1.35	0.2-0.6	0.18-0.20	3.0-5.9	3.0-5.0
	2-13	8	52	35-45	1.25-1.45	0.2-0.6	0.14-0.16	3.0-5.9	1.0-2.0
	13-61	18	51	27-35	1.30-1.50	0.2-0.6	0.14-0.16	3.0-5.9	0.5-1.0

Table 18.—Erosion Properties

(Entries under "Erosion factors" apply to the entire profile. Entries under "Wind erodibility group" and "Wind erodibility index" apply only to the surface layer)

Map unit symbol and soil name	Depth (inches)	Erosion factors: Kw	Erosion factors: Kf	Erosion factors: T	Wind erodibility group	Wind erodibility index
345897:						
Clapper	0-4	.15	.28	5	7	38
	4-16	.17	.32			
	16-60	.10	.37			
Midway	0-2	.24	.24	2	6	48
	2-11	.28	.28			
	11-60	---	---			
345971:						
Glenberg	0-5	.24	.24	5	3	86
	5-60	.20	.20			
Haverson	0-12	.32	.32	5	5	56
	12-60	.32	.32			
345982:						
Haverson	0-12	.32	.32	5	5	56
	12-60	.32	.32			
345992:						
Heldt	0-4	.32	.32	5	6	48
	4-10	.37	.37			
	10-22	.37	.37			
	22-60	.37	.37			
345999:						
Hesper	0-6	.37	.37	4	6	48
	6-14	.28	.28			
	14-22	.32	.32			
	22-49	.37	.37			
	49-60	.02	.02			
346062:						
Midway	0-2	.32	.32	2	6	48
	2-11	.28	.28			
	11-60	---	---			
346063:						
Midway	0-2	.32	.32	2	6	48
	2-11	.28	.28			
	11-60	---	---			
346097:						
Lismas	0-6	.17	.17	2	4	86
	6-18	.24	.24			
	18-60	---	---			
Pierre	0-3	.20	.20	3	4	86
	3-29	.32	.32			
	29-60	---	---			
346102:						
Pierre	0-3	.20	.20	3	4	86
	3-29	.32	.32			
	29-60	---	---			

Table 18.—Erosion Properties—Continued

Map unit symbol and soil name	Depth (inches)	Erosion factors			Wind erodi-bility group	Wind erodi-bility index
		Kw	Kf	T		
346139. Rock outcrop, shale						
346140: Rock outcrop, shale.						
Midway	0-2	.32	.32	2	6	48
	2-11	.28	.28			
	11-60	---	---			
346194: Thurlow	0-2	.24	.24	5	6	48
	2-13	.32	.32			
	13-61	.43	.43			
346196: Thurlow	0-2	.24	.24	5	6	48
	2-13	.32	.32			
	13-61	.43	.43			

Table 19.—Total Soil Carbon

(This table displays soil organic carbon (SOC) and soil inorganic carbon (SIC) in kilograms per square meter to a depth of 2 meters or to the representative top depth of any kind of bedrock or any cemented soil horizon. SOC and SIC are reported on a volumetric whole soil basis, corrected for representative rock fragments indicated in the database. SOC is converted from horizon soil organic matter of the fraction of the soil less than 2 mm in diameter. If soil organic matter indicated in the database is NULL, SOC is assumed to be zero. SIC is converted from horizon calcium carbonate content fraction of the soil less than 2 mm in diameter. If horizon calcium carbonate indicated in the database is NULL, SIC is assumed to be zero. A weighted average of all horizons is used in the calculations. Only major components of a map unit are displayed in this table)

Map unit symbol, component name, and component percent	SOC	SIC
	kg/m^2	kg/m^2
345897:		
Clapper (55%)	3	27
Midway (35%)	1	3
345971:		
Glenberg (45%)	10	19
Haverson (45%)	10	8
345982:		
Haverson (90%)	10	8
345992:		
Heldt (90%)	10	24
345999:		
Hesper (90%)	11	13
346062:		
Midway (90%)	1	3
346063:		
Midway (80%)	1	3
346097:		
Lismas (60%)	1	2
Pierre (30%)	5	11
346102:		
Pierre (85%)	5	11
346139.		
Rock outcrop, shale (80%)		
346140:		
Rock outcrop, shale (45%)	0	
Midway (35%)	1	3

Table 19.—Total Soil Carbon—Continued

Map unit symbol, component name, and component percent	SOC	SIC
	kg/m^2	kg/m^2
346194:		
Thurlow (85%)	12	20
346196:		
Thurlow (85%)	12	20

Table 20.—Chemical Soil Properties

(Absence of an entry indicates that data were not estimated)

Map unit symbol and soil name	Depth	Cation-exchange capacity	Soil reaction	Calcium carbon-ate	Salinity	Sodium adsorp-tion ratio
	In	meq/100 g	pH	Pct	mmhos/cm	
345897:						
Clapper	0-4	10.0-15.0	7.9-8.4	0	0.0-2.0	0
	4-16	10.0-15.0	7.9-9.0	5-15	0.0-4.0	0
	16-60	5.0-10.0	7.9-9.0	15-40	0.0-4.0	0
Midway	0-2	20.0-25.0	6.6-7.8	0	0	0
	2-11	20.0-25.0	7.4-8.4	5-10	0	0
	11-60	---	---	---	---	---
345971:						
Glenberg	0-5	10.0-15.0	6.6-9.0	1-5	0.0-4.0	0
	5-60	10.0-15.0	7.4-9.0	5-10	2.0-8.0	0
Haverson	0-12	15.0-20.0	7.4-8.4	1-5	0.0-2.0	0
	12-60	15.0-25.0	7.4-8.4	1-5	0.0-4.0	0
345982:						
Haverson	0-12	15.0-20.0	7.4-8.4	1-5	0.0-2.0	0
	12-60	15.0-25.0	7.4-8.4	1-5	0.0-4.0	0
345992:						
Heldt	0-4	25.0-30.0	6.6-8.4	0-5	0.0-2.0	1-4
	4-10	20.0-25.0	7.4-8.4	5-10	0.0-2.0	5-10
	10-22	20.0-25.0	7.9-8.4	5-15	0.0-2.0	5-10
	22-60	20.0-25.0	7.9-9.0	5-15	0.0-2.0	5-10
345999:						
Hesper	0-6	20.0-25.0	6.6-7.3	0	0	0
	6-14	25.0-35.0	6.6-7.3	0	0	0
	14-22	20.0-30.0	7.4-7.8	0	0	0
	22-49	15.0-20.0	7.9-8.4	5-15	0.0-2.0	0
	49-60	0.0-1.0	7.9-9.0	0-5	0.0-2.0	0
346062:						
Midway	0-2	20.0-25.0	6.6-7.8	0	0	0
	2-11	20.0-25.0	7.4-8.4	5-10	0	0
	11-60	---	---	---	---	---
346063:						
Midway	0-2	20.0-25.0	6.6-7.8	0	0	0
	2-11	20.0-25.0	7.4-8.4	5-10	0	0
	11-60	---	---	---	---	---
346097:						
Lismas	0-6	30.0-40.0	6.6-8.4	0	0.0-2.0	0
	6-18	30.0-40.0	6.6-8.4	1-5	0.0-4.0	0
	18-60	---	---	---	---	---
Pierre	0-3	30.0-40.0	7.4-8.4	1-5	0.0-4.0	0
	3-29	25.0-40.0	7.4-9.0	5-15	0.0-4.0	0-2
	29-60	---	---	---	---	---
346102:						
Pierre	0-3	30.0-40.0	7.4-8.4	1-5	0.0-4.0	0
	3-29	25.0-40.0	7.4-9.0	5-15	0.0-4.0	0-2
	29-60	---	---	---	---	---

Table 20.—Chemical Soil Properties—Continued

Map unit symbol and soil name	Depth	Cation-exchange capacity	Soil reaction	Calcium carbon-ate	Salinity	Sodium adsorp-tion ratio
	In	meq/100 g	pH	Pct	mmhos/cm	
346140:						
Midway	0-2	20.0-25.0	6.6-7.8	0	0	0
	2-11	20.0-25.0	7.4-8.4	5-10	0	0
	11-60	---	---	---	---	---
346194:						
Thurlow	0-2	20.0-25.0	6.6-7.3	0	0	0
	2-13	25.0-30.0	6.6-8.4	0	0.0-2.0	0
	13-61	20.0-25.0	7.4-8.4	5-15	0.0-2.0	0
346196:						
Thurlow	0-2	20.0-25.0	6.6-7.3	0	0	0
	2-13	25.0-30.0	6.6-8.4	0	0.0-2.0	0
	13-61	20.0-25.0	7.4-8.4	5-15	0.0-2.0	0

Table 21.—Water Features

(See text for definitions of terms used in this table. Estimates of the frequency of ponding and flooding apply to the whole year rather than to individual months. Absence of an entry indicates that the feature is not a concern or that data were not estimated. Depth to water table is based on a representative value)

Map unit symbol and soil name	Hydro-logic group	Months	Water table: Upper limit	Water table: Lower limit	Ponding: Surface water depth	Ponding: Duration	Ponding: Frequency	Flooding: Duration	Flooding: Frequency
			Ft	Ft	Ft				
345897:									
Clapper	B								
		Jan-Dec	---	---	---	---	None	---	None
Midway	D								
		Jan-Dec	---	---	---	---	None	---	None
345971:									
Glenberg	A								
		April	---	---	---	---	None	Brief	Occasional
		May	---	---	---	---	None	Brief	Occasional
		June	---	---	---	---	None	Brief	Occasional
Haverson	B								
		April	---	---	---	---	None	Brief	Occasional
		May	---	---	---	---	None	Brief	Occasional
		June	---	---	---	---	None	Brief	Occasional
345982:									
Haverson	B								
		April	---	---	---	---	None	Brief	Occasional
		May	---	---	---	---	None	Brief	Occasional
		June	---	---	---	---	None	Brief	Occasional
345992:									
Heldt	C								
		Jan-Dec	---	---	---	---	None	---	None
345999:									
Hesper	C								
		Jan-Dec	---	---	---	---	None	---	None
346062:									
Midway	D								
		Jan-Dec	---	---	---	---	None	---	None
346063:									
Midway	D								
		Jan-Dec	---	---	---	---	None	---	None

Table 21.—Water Features—Continued

Map unit symbol and soil name	Hydro-logic group	Months	Water table: Upper limit	Water table: Lower limit	Ponding: Surface water depth	Ponding: Duration	Ponding: Frequency	Flooding: Duration	Flooding: Frequency
			Ft	Ft	Ft				
346097:									
Lismas	D								
		Jan-Dec	---	---	---	---	None	---	None
Pierre	D								
		Jan-Dec	---	---	---	---	None	---	None
346102:									
Pierre	D								
		Jan-Dec	---	---	---	---	None	---	None
346139.									
Rock outcrop, shale									
346140:									
Rock outcrop, shale.									
Midway	D								
		Jan-Dec	---	---	---	---	None	---	None
346194:									
Thurlow	C								
		Jan-Dec	---	---	---	---	None	---	None
346196:									
Thurlow	C								
		Jan-Dec	---	---	---	---	None	---	None

Table 22.—Soil Features

(See text for definitions of terms used in this table. Absence of an entry indicates that data were not estimated)

Map unit symbol and soil name	Restrictive layer		Potential for frost action	Risk of corrosion	
	Kind	Depth to top		Uncoated steel	Concrete
		In			
345897:					
Clapper	---	---	Low	Moderate	High
Midway	Paralithic bedrock	10-20	Low	High	Low
345971:					
Glenberg	---	---	Moderate	High	Moderate
Haverson	---	---	Moderate	High	Moderate
345982:					
Haverson	---	---	Moderate	High	Moderate
345992:					
Heldt	---	---	Low	High	High
345999:					
Hesper	---	---	Low	High	High
346062:					
Midway	Paralithic bedrock	10-20	Low	High	Low
346063:					
Midway	Paralithic bedrock	10-20	Low	High	Low
346097:					
Lismas	Paralithic bedrock	10-20	Low	High	Moderate
Pierre	Paralithic bedrock	20-40	Low	High	Moderate
346102:					
Pierre	Paralithic bedrock	20-40	Low	High	Moderate
346139.					
Rock outcrop, shale					
346140:					
Rock outcrop, shale.					
Midway	Paralithic bedrock	10-20	Low	High	Low
346194:					
Thurlow	---	---	Low	High	Low
346196:					
Thurlow	---	---	Low	High	Low

Table 23.—Taxonomic Classification of the Soils

Soil name	Family or higher taxonomic class
Allentine	Fine, smectitic Borollic Natrargids
Clapper	Loamy-skeletal, mixed, superactive, mesic Ustollic Calciorthids
Eltsac	Very fine, smectitic, frigid Udorthentic Chromusterts
Glenberg	Coarse-loamy, mixed (calcareous), superactive, calcareous, frigid Ustic Torrifluvents
Harvey	Fine-loamy, mixed, superactive, mesic Ustollic Calciorthids
Haverson	Fine-loamy, mixed (calcareous), superactive, calcareous, frigid Ustic Torrifluvents
Havre	Fine-loamy, mixed (calcareous), superactive, calcareous, frigid Ustic Torrifluvents
Heldt	Fine, smectitic Borollic Camborthids
Hesper	Fine, smectitic, mesic Ustollic Haplargids
Hydro	Fine, smectitic, mesic Glossic Ustollic Natrargids
Keiser	Fine-silty, mixed, superactive, mesic Ustollic Haplargids
Kyle	Fine, smectitic, frigid Udorthentic Chromusterts
Lismas	Clayey, smectitic (calcareous), nonacid, frigid, shallow Ustic Torriorthents
Lohmiller	Fine, smectitic Borollic Camborthids
McRae	Fine-loamy, mixed, superactive, mesic Ustollic Camborthids
Midway	Clayey, smectitic (calcareous), calcareous, frigid, shallow Ustic Torriorthents
Nelson	Coarse-loamy, mixed, superactive, frigid Typic Ustochrepts
Norbert	Clayey, smectitic (calcareous), calcareous, frigid, shallow Typic Ustorthents
Pierre	Fine, smectitic, frigid Udorthentic Chromusterts
Thedalund	Fine-loamy, mixed, superactive Borollic Camborthids
Thurlow	Fine, smectitic, mesic Ustollic Haplargids

Table 24.—Soil Classification Key

ORDER Suborder Great Group Subgroup Series or Higher Category	
ARIDISOLS	
Argids	
Haplargids	
Ustollic Haplargids	
Hesper	Fine, smectitic, mesic Ustollic Haplargids
Thurlow	Fine, smectitic, mesic Ustollic Haplargids
Keiser	Fine-silty, mixed, superactive, mesic Ustollic Haplargids
Natrargids	
Borollic Natrargids	
Allentine	Fine, smectitic Borollic Natrargids
Glossic Ustollic Natrargids	
Hydro	Fine, smectitic, mesic Glossic Ustollic Natrargids
Orthids	
Calciorthids	
Ustollic Calciorthids	
Harvey	Fine-loamy, mixed, superactive, mesic Ustollic Calciorthids
Clapper	Loamy-skeletal, mixed, superactive, mesic Ustollic Calciorthids
Camborthids	
Borollic Camborthids	
Heldt	Fine, smectitic Borollic Camborthids
Lohmiller	Fine, smectitic Borollic Camborthids
Thedalund	Fine-loamy, mixed, superactive Borollic Camborthids
Ustollic Camborthids	
McRae	Fine-loamy, mixed, superactive, mesic Ustollic Camborthids
ENTISOLS	
Fluvents	
Torrifluvents	
Ustic Torrifluvents	
Glenberg	Coarse-loamy, mixed (calcareous), superactive, calcareous, frigid Ustic Torrifluvents
Haverson	Fine-loamy, mixed (calcareous), superactive, calcareous, frigid Ustic Torrifluvents
Havre	Fine-loamy, mixed (calcareous), superactive, calcareous, frigid Ustic Torrifluvents
Orthents	
Torriorthents	
Ustic Torriorthents	
Midway	Clayey, smectitic (calcareous), calcareous, frigid, shallow Ustic Torriorthents
Lismas	Clayey, smectitic (calcareous), nonacid, frigid, shallow Ustic Torriorthents
Ustorthents	
Typic Ustorthents	
Norbert	Clayey, smectitic (calcareous), calcareous, frigid, shallow Typic Ustorthents
INCEPTISOLS	
Ochrepts	
Ustochrepts	
Typic Ustochrepts	
Nelson	Coarse-loamy, mixed, superactive, frigid Typic Ustochrepts
VERTISOLS	
Usterts	
Chromusterts	
Udorthentic Chromusterts	
Kyle	Fine, smectitic, frigid Udorthentic Chromusterts
Pierre	Fine, smectitic, frigid Udorthentic Chromusterts
Eltsac	Very fine, smectitic, frigid Udorthentic Chromusterts

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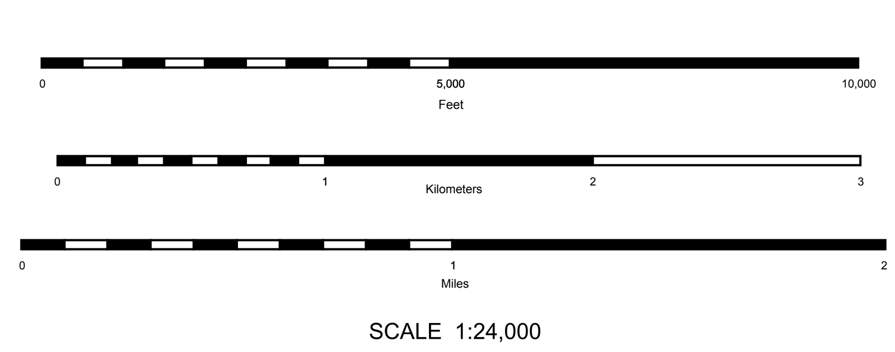
UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

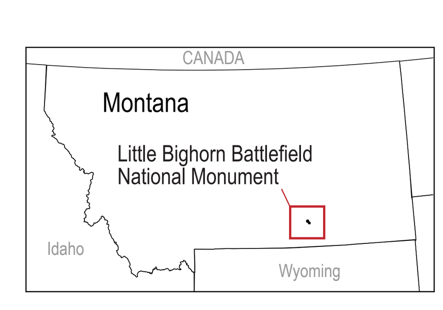
SOIL SURVEY OF LITTLE BIGHORN BATTLEFIELD NATIONAL MONUMENT, MONTANA
PORTIONS OF CROW AGENCY AND CROW AGENCY SE QUADRANGLES
SHEET NUMBER 1 OF 1

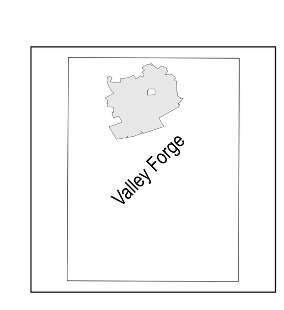
This soil survey was compiled by the U.S. Department of Agriculture, Natural Resources Conservation Service, at the request of the Department of the Interior, National Park Service. Base maps are orthophotographs prepared by the U.S. Department of Agriculture, Farm Service Agency from 2006 - 2011 aerial photographs. A 2013 National Park Service boundary was used. Soil information was derived from USDA/NRCS Soil Survey Geographic (SSURGO) database for Little Bighorn Battlefield National Monument. Universal Transverse Mercator Zone 13 North, North American Datum of 1983 (NAD83).



SCALE 1:24,000

North





Little Bighorn Battlefield
National Monument,
Montana

Sheet 1 of 1

U.S. DEPARMENT OF AGRICULTURE

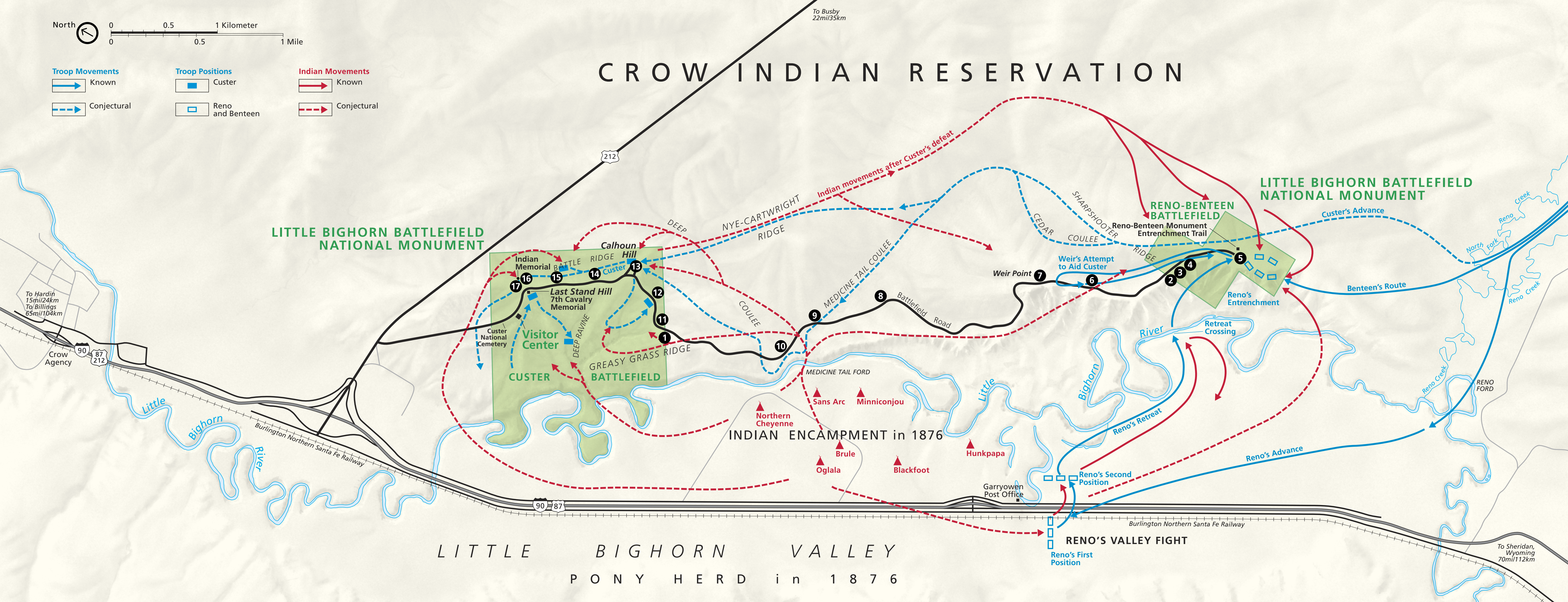
NATURAL RESOURCES CONSERVATION SERVICE

MAP UNIT LEGEND
LITTLE BIGHORN BATTLEFIELD NATIONAL MONUMENT, MONTANA

U.S. DEPARTMENT OF THE INTERIOR

NATIONAL PARK SERVICE

SYMBOL	NAME
345897	Clapper-Midway complex, hilly
345971	Haverson and Glenberg soils
345982	Haverson loam, 0 to 2 percent slopes
345992	Heldt silty clay loam, 4 to 8 percent slopes
345999	Hesper silty clay loam, 4 to 8 percent slopes
346062	Midway silty clay loam, rolling
346063	Midway silty clay loam, hilly
346097	Pierre-Lismas clays, hilly
346102	Pierre clay, rolling
346139	Shale outcrop
346140	Shale outcrop-Midway complex, steep
346194	Thurlow silty clay loam, 0 to 1 percent slopes
346196	Thurlow silty clay loam, 4 to 8 percent slopes



North
0 0.5 1 Kilometer
0 0.5 1 Mile
Troop Movements
Known
Conjectural
Troop Positions
Custer
Reno and Benteen
Indian Movements
Known
Conjectural
To Busby 22mi/35km
CROW INDIAN RESERVATION
212
LITTLE BIGHORN BATTLEFIELD NATIONAL MONUMENT
Indian movements after Custer's defeat
NYE-CARTWRIGHT RIDGE
DEEP COULEE
Calhoun Hill
Indian Memorial
BATTLE RIDGE
Custer
Last Stand Hill 7th Cavalry Memorial
Custer National Cemetery
Visitor Center
DEEP RAVINE
GREASY GRASS RIDGE
CUSTER BATTLEFIELD
MEDICINE TAIL COULEE
MEDICINE TAIL FORD
Battlefield Road
Weir Point
Weir's Attempt to Aid Custer
CEDAR COULEE
SHARPSHOOTER RIDGE
RENO-BENTEEN BATTLEFIELD
Reno-Benteen Monument Entrenchment Trail
Reno's Entrenchment
LITTLE BIGHORN BATTLEFIELD NATIONAL MONUMENT
Custer's Advance
Benteen's Route
North Fork Reno Creek
Reno Creek
RENO FORD
Retreat Crossing
Reno's Retreat
Reno's Advance
Reno's Second Position
Reno's First Position
RENO'S VALLEY FIGHT
Sans Arc
Minniconjou
Northern Cheyenne
INDIAN ENCAMPMENT in 1876
Brule
Oglala
Blackfoot
Hunkpapa
Garryowen Post Office
Little Bighorn River
To Hardin 15mi/24km
To Billings 65mi/104km
Crow Agency
90 87 212
Burlington Northern Santa Fe Railway
LITTLE BIGHORN VALLEY
PONY HERD in 1876
To Sheridan, Wyoming 70mi/112km
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17